

Soul, Freedom and Truth: Their Relationships with Noetical Algorithmic Incompleteness

Mario Antonio Zatti

ABSTRACT

Since the act of free will must affect synaptic events, where does the energy necessary to induce action potentials of cerebral neurons and synaptic webs come from? The exercise of free will requires the cerebral hardware to be flexible, i.e. it must have an indeterministic character in order to allow a free act to orient this instability in making a choice, thereby reducing the entropy of the system, but a preliminary free act which wants to expend a certain amount of energy is needed, that is, another free act should be involved anterior to, and different from, the orientation of the instability itself, and this also needs a related expenditure of energy, this in turn requiring its own free act to take place... One cannot escape the resort to the infinite. A thermodynamic machine has to dissipate the energetic equivalent of one bit of information to make a choice between two equiprobable events, whereas an immaterial agent does not, nor does it violate any physical law if it is capable of acting on a substrate within the limit of its quantum mechanical indeterminacy. A second parallel aspect in the present discussion has to do with the consequences of Gödel's theorems of incompleteness concerning mathematics and everything which is subject to logical laws. Gödel has definitively proved that for any logical system there are infinite truths which are not provable, but which the human intellect sees them just as truths. Noetical algorithmic incompleteness together with the necessary separation of the notions of demonstrableness (object language) and truth (metalanguage) speaks of a dualism supporting creativity and truth and freedom. In fact, if human actions, in the absence of any involuntary impulse, should always be connected to logico-mathematical inferences, they should be always completely predictable.

Key Words: free will, logical incompleteness, quantum vitalism, soul, freedom, truth

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1. Introduction

Neuroscientists face with some difficulty the problem of the conscience-brain relationship, which in fact has been defined by Chalmers (1996) and is generally known as the "hard problem" of neuroscience; philosophers too consider conscience as a hard problem, due to the hindrance of evocating doubtful immaterial phenomena. Theories which were apparently well consolidated, and which were believed to have identified three regions of the brain as specific to

the self-awareness which is central to human consciousness (the insula, anterior cingulate and medial prefrontal cortices) are now falling. It has recently been demonstrated that human self-awareness is correlated with neurological processes involving diffuse cerebral webs and not specific limited regions (Philippi *et al.*, 2012). Another problem must be taken into consideration, and this is the complex type of causality between neural functions and conscious processes, these being emergent as "top down"

Corresponding author: Mario Zatti

Address: Formerly Director of the Department of Biomedical Sciences – Verona University, Italy. Address: via Coni Zugna 14, 37126 Verona – Italy

Phone: + 39 339 1918185

e-mail ✉ mariozatti@libero.it

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influences in a sort of circular causality, owing to the reciprocity of the relations. According to Wurzman and Giordano (2009) the hard problem exists because an explanation is sought only considering an efficient cause of events, and only in the sense of the mechanisms through which consciousness could arise from the processes of the neural substrate. In this matter, the efficient mechanism is inextricable from formal and final causes: every type of cause is involved, in a convergence and reciprocity which imply that the designation of the events as causes or effects may be ambiguous. In spite of the above complexity, and particularly in view of the circularity of causal actions, let us attempt some exploration of the theme of the possibility of free choices by the system.

It is well known that conscious activity is connected to biochemical and electrical manifestations of cerebral function. Such function is not subject to determinism: the variations of activity of neurons combined with the secretion and the bond to receptors of the neurotransmitters show that cerebral functions take place far from thermodynamic equilibrium, and in such conditions entropy production can entail a non-deterministic character of the cerebral function. Quantum indeterminacy and nonlinear chaotic dynamics account for the instability and the extreme sensitivity of the entire cerebral *hardware*, i.e. the necessary though not sufficient condition for the exercise of freedom by human beings.

Since volition acts on synaptic events, the power of choice between to do or not to do, for instance to choose between two states corresponding to two desires of equal force, requires that the act of will can result in a compression of the entropy of the synaptic states due to the furnishing of information, which reduces uncertainty.

Szilard (1929) published a study entitled "*On the reduction of entropy in a thermodynamic system caused by an intelligent being*", giving examples of the application of Maxwell's idea ("Maxwell's demon", widely discussed since 1871)

² In a cylinder containing one molecule of gas and divided into two halves by a partition piston, if a demon determines which side the molecule is on, he could obtain work without any expenditure of energy. If the force of the molecule colliding with the piston is $k_B T/L$ (k_B Boltzmann constant, T absolute temperature, L distance between the piston and the extremity of the cylinder), the work of the molecule to double L is $k_B T \log_2 2$. But to make afresh such space in the demon's memory, the minimal energy needed (at room temperature), being in question 1 bit of information to be removed, must be just $k_B T \log_2 2$
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of procedures for the reduction of entropy by means of a memory. Owing to the mathematical relation between physical entropy and uncertainty or informational entropy, the reduction of entropy of synaptic states, caused by a mental choice acting within the competence of physical laws, will always represent the removal of uncertainty, that is information supply, necessarily supported by an energetic cost paid by the system.²

The problem of free choice has to do with the possibility that a system possessing indeterminacy or fundamental instability, such as the neural network, may be oriented in such a way that, after the choice has been made, it may find itself in one of its 2^n possible states, inasmuch as this compression (reduction of entropy) corresponds to the act of free will. Every time a reduction of entropy of the synaptic state, operated by a mental choice, takes place, it will necessarily be accompanied (as the laws of thermodynamics dictate) by heat exchanges with the environment or by equivalent variations of the entropy of a memory. In fact, if the system is material, it has to expend energy to effect the instability orientation (reduction of entropy) which should correspond to the act of free will. That is to say, the system should want to expend energy, and this free act would be prior to and different from the instability orientation: this decision in turn requires energy dissipation which in turn requires an act of will... One would have to resort to infinity.

This can only be avoided if a system does not require physical means in the act of choosing: what is needed is an uncaused causality, an immaterial intelligence that no exclusively physical system (in which for every bit of information transferred a corresponding amount of energy must be dissipated) possesses. Otherwise, man is not free. Popper and Eccles (1977) extensively explain that an immaterial causality does not violate any physical law because it acts upon what, in the realm of quantum mechanics, is indeterminate.

$=10^{-27}$ KWh in the appropriate units. Not even a demon, if physical laws are not violated, could operate net reductions of entropy. Brillouin L. Scientific Uncertainty and Information. Academic Press, New York, 1964. Landauer R. Dissipation and Noise Immunity in Computation and Communication. Nature 1988; 335: 779-784. Bérut A. *et al.* Experimental verification of Landauer's principle linking information and thermodynamics. Nature 2012; 483: 187-189.



According to Boncinelli (2012), one's self can be willing, but it is no other than the brain. I believe it should differ, since a free responsible act cannot exist by remaining on the field of physical efficient causes, at least unless we want to look upon some biochemical reaction as free and responsible. It also seems that scientific reasoning has to stop here, and we must enter the realm of metaphysics. What has been discussed so far means that the brain must be endowed with a certain measure of indeterminacy, which is necessary in order to give hospitality to free will. This is not sufficient however, because an immaterial form must be active.

Darwin wrote that, although great, the difference between the human mind and that of the highest animals is one of degree and not of quality (Darwin, 1998). This is half a truth: the brain in fact, *as far as the immaterial self is not involved*, performs functions of receptivity, association, memory and stimulation, that in man that in some animals take place without qualitative differences. In view of the above considerations, even without an exhaustive philosophical discussion, we may infer that a free action must have an immaterial principle, or some complement of a mere physical causation (mechanical, rational, computational, algorithmic). Today's physics gives an incomplete comprehension of causality in the real world since it does not take into consideration human volition, which is clearly causally efficient (Ellis, 2005). On this matter, philosophy offers a number of different perspectives (Various Authors, 2004, 2013). An interesting idea was put forward by Whitehead (1933) - analogously to those of Teilhard de Chardin (1955), and of the theologian Ratzinger (2012) who defined matter as "prehistory of spirit" - according to which something psychic pertains to all nature, but a high level psychic emergence ("reflexive thought" of Teilhard) is conditioned to the evolution of special complexes of occasions: in particular, the power of actualizing potentialities modifying quantum mechanical linear dynamics may pervade all of nature, although it is non-negligible only in systems with high psychical excellence.

2. Quantum vitalism

We must in fact take into account a fundamental condition for man's freedom: the presence of chance, albeit a limited one, which seems to give form to a sort of "freedom" of nature. The human

freedom requires an all-important immaterial subject and a recall to the anthropic principle in so far as nature shows a degree of casualty bearing contingency, and limits to the action of fixed mathematical laws and the Laplacian identification of causality and determinism. Introducing stochasticity at a fundamental level (the inherent statistic character of atomic-subatomic events) implicates that "...every individual quantum event may be genuinely unpredictable" (Davies, 1992) although a collection of such events conforms to the statistical predictions of quantum mechanics. Statistical laws are in fact deterministic when they concern a collection of objects.

As far as Leibniz's principle of sufficient reason (*La Monadologie* 1714; II 31-40) is concerned, Davies (1992) argues that if some space exists in nature for genuine, inherent stochasticity, there the outcome of any particular throw of the dice is undetermined by anything;

"Imagine an electron colliding with an atom. Quantum mechanics tells us that there is, say, equal probability that the electron will deflect to the left as to the right. [...] If the electron actually deflects to the left, there will be no reason whatever why it has done so..."

This sentence finds a philosophical resonance in Antiseri's remarks (1987) about "the insufficient defense" which could be rationally brought to the principle. However, it is not possible to surrender the principle of sufficient reason without relinquishing reason tout court. Anyhow, it must be a truth concerning all events (*essendi, fiendi*) in accordance with one of the definitions given by Leibniz: "Nothing happens without a reason". The discussion brings us to ask: where does chance come from? In fact, it must exist, as an accidental cause, notwithstanding the ease of believing that in reality it does not exist, but is the result of our ignorance or inadequate accuracy of observations of processes and initial conditions. There is, however, a second answer, as Ekeland (1992) observes, which consists in saying that chance is the result of independent causal sets. "This answer seemed idiotic to me when I was a child, and it seems even more idiotic now, inasmuch as there are no independent causal sets in the universe...". This opinion implies a deterministic view of the universe in which the meeting of causal sets cannot be, by definition, a fortuitous case, even though it might appear so. At the root of any real physical contingency, of the creativity of evolution, or of the existence of free,



sentient beings, there must be a certain framework of a lack of necessitating causal constrictions. There would be nothing truly fortuitous, or new, if this root of intrinsic indeterminacy were lacking. It does exist, at least in the submicroscopic quantum world, as well as in the bifurcation points of chaotic systems, whose nonlinear dynamics are amplifiers even of only minimal accidental variations.

Eccles (1990) described the quantum uncertainty demonstrable in the junctions between neurons (*synapses*) in which the stimulus passes from one neuron to another via the release of biochemical quanta of neurotransmitters. These are contained in vesicles whose membrane can fuse as a result of the actions produced by the nerve stimulus with that of the junction (presynaptic membrane), causing the emptying of the vesicle and the emission of the neurotransmitter. The mass of the vesicle, in fact, is not such as to exceed the limits of the Heisenberg uncertainty equation and therefore could be affected by the magnitude of the effect produced by a quantum mechanics probability wave. Hameroff and Penrose (1996) suggested that consciousness may be related to a quantum wave function collapsing in structures in the brain's neurons, called microtubules. According to Penrose, Swinburn (1986) and others, if the only source of indeterminacy in the physical world were that of quantum states, this would be enough to guarantee scope for non-computability, the possibility unrelated to algorithmic processes allowing the exercise of human intelligence and freedom.

This basically echoes the attempts made by the ancient Epicurus, exactly resumed by Lucretius (*De rerum natura* II° vv 251-293), to describe an indeterminacy of the atomic motions (*clinamen*) as a justification of free will.

There are many different philosophical opinions on this matter, from hard determinism incompatible with the existence of free will, to compatibilism or semicompatibilism, to impossibilism with regard to moral responsibility, right up to supporters of the preservation of the public illusion of free will in order to contribute to the maintenance of public morality. There is also, on the other side, so-called libertarianism, variously and sometimes vaguely defined. Very extensive research can find some synthesis in the work of Doyle (2011).

Some claim the acausality (absolute chance) of events of the submicroscopic quantum world. It is fairly obvious that we are talking about a minority. They have to regard as acceptable the hypothesis of events arising from nothing. Yet they have some arguments to support their claim. In the subatomic world the interactions (forces) between particles are transferred by other particles: if motions can exist only as a result of the actions of external forces on the particles, one of these would not be able to move without the action (cause) of a force, but on the other hand the force cannot exist if there are no moving particles to transfer it: either everything is immobile, or there are uncaused spontaneous motions (Gao, 2001, 2003). Some limits to physical causality, in view of the elementary material indeterminacy, must be considered, and the concept of indeterministic causality has been proposed, as we shall see. Nevertheless, it is always difficult to justify this ambiguous concept, as it is in general to admit the existence of truly contingent causes, without coherently reaching the point of accepting some framework of objective *physical* acausality in nature governed by laws, so much so, indeed, that most of the examples regarding chance, from the creditor who meets his debtor in the marketplace (Aristotle, *Physica* II 5) to the tinsmith whose hammer falls just when doctor Dupont is passing (Monod, 1970), have always been related to human acts, implying the existence of a *psychic* cause at the origin of the contingent causal set to which a fortuitous event is due. It may be suggestive to compare the macroscopic unpredictability due to causal sets of psychic origin, as in the examples of the type recalled above, with that of the submicroscopic world where it may also be possible to postulate a psychic cause - instead of a lack of causes - of fortuitous events. The logical basis of indeterminism is provided by the demonstration that the motion of elementary particles is discontinuous, random and spontaneous: *self-movement* is in fact a typical immanent property of *animated* beings. And going back to what was said about the powers of the soul and its gradual emergence (causal powers other than physical power), the same could be said also for the inherent root of indeterminacy, which could then be the same as freedom, and may remind us of Teilhard's great insight (1955): "We are logically forced to assume in rudimentary form the existence of some sort of psychic form in every corpuscle...". The concept is still current: a recent

article in *NeuroQuantology* (Argonov, 2012) has an expressive title: *Neural Correlate of Consciousness in a Single Electron....* Viewing the matter in this aspect does not put away the principle of sufficient reason.

These ideas should not be considered as an expression of the propensity to mysticism or as getting off the lines of scientific reasoning. It may be enough to remember the title of a book by Davies and Brown: *The ghost in the atom* (1986). Bohr, one of the fathers of quantum physics, wrote that anybody who is not shocked by quantum theory does not understand it (French and Kennedy, 1985). In the quantum world a particle is a wave, and a wave is a particle. The famous Schrödinger's cat can be in a superposition of states, both dead and alive, depending on an earlier random event (Gribbin, 1985). In the notorious double slit experiment, a photon acts either like a particle or like a wave, but not both. But also one photon can pass through both slits at once and interfere with itself. A subtle connexion can exist between two particles (entanglement) whereby a measurement operated on one of them causes on the other, even at a distance of light-years, an instantaneous condition no longer characterized by indetermination. Physicists have even created quantum links between photons that don't exist at the same time (Cho, 2013; Megidish *et al.*, 2013). These and similar aspects explain how scientists have spoken of the "metaphysics of quantum theory" (Krips, 1987), although there are incontestable experimental confirmations of it.

D'Espagnat (2006), considering that a quantum measurement of an object can give a multiplicity of possible results, so that the original quantum state must be considered indetermined, thus making impossible any definite scientific description of reality as it really is, spoke of "veiled reality" that science will not be able to know exhaustively. Asked whether this could lead to some sort of mysticism he said in reply that science is not all. In a philosophical prospect, it is not difficult to see in the veiled reality an analogy with the noumenon of the Kantian *Critique of Pure Reason*. According to Husserl (1901) "... with regard to their matter, objects remain fully not determinate, being determined only by the form of their connections". Husserl's notion of 'object' seems to correspond to that of the 'particular' of analytical metaphysics or to that of the 'individual' of logic, and the notion of 'law which regulates a connexion' to that of the 'property of a relation' (Masolo *et al.*, 2003). The concept of a particular

and not universal property having an existence of its own has led to the introduction of a new name for it: 'trope'. According with this ontology, things are nothing but bundles of properties. What does really exist is represented by properties and relations. This is an old problem. What physical reality can the fundamental particles of matter have (Kuhlmann, 2013)? The problem is not whether they exist, but what are they made of. If they are really fundamental, what matter could they be made of? On a more technical plane the theory of hidden variables postulates that the wave-function represents an objectively real field in a state of rapid casual fluctuation deriving from a deeper subquantum level, much in the same way as the fluctuations of the Brownian motion of a droplet of liquid derive from the underlying atomic level. The behaviour of the field appears to be indetermined, but the precise dynamics of the fluctuations is caused by a hypothetical "implicate order", which may also be understood as the primary reality of the substance of consciousness (Bohm, 1996). Bohm's theory, often quoted and seldom partaken, has been also recently submitted to a rather radical criticism as far as mental/material interrelations are concerned (Malech and Amani, 2012). Bohm affirmed: "Quantum physics sees mind and matter as *implicated...*"; and already Cusano (1440) used the latin word "*implicatio*" putting forward a rather similar idea some centuries ago, also denying the possibility of knowing the "*quidditas*" of things. In conclusion, the existence of chance, as we have outlined it, can be traced to an intrinsic indeterminacy of matter, for which two hypotheses can be propounded:

1. that at the elementary level the relationships correspond to a non-deterministic physical causality, as was first claimed by Sommerfield, de Broglie and Born, (Born, 1949) which requires the separation of the notion of causality from that of determinism, and the use of the concept of "probabilistic causality", perhaps better interpreted as deterministic cause of probabilities (Weinert, 2000);
2. that a psychic causal power operates at the elementary level in the single particles of the quantum world, already present albeit without any claim of awareness, capable of blindly influencing quantum events inducing random effects.



Chance as we know it in physics and by common sense must in any event be referred to a fundamental, though very limited, framework of *physical* acausality. It is, in any case, important to note that the inherent stochasticity of quantum mechanics, a condition of total randomness - the equity of the quantum game of dice - is itself a fairly restrictive law of nature.

As for the accusation of vitalism that could be brought against some of the possibilities described, it may be useful to consult the article entitled *Quantum Vitalism* by Hameroff (1997):

"...functional descriptions fail to capture an essential self-organizing "unitary oneness" present in living systems. To nineteenth-century biologists this quality was ascribed to a "life force", "élan vital", or "energy field". Then, as molecular and cell biology began to reveal the biochemical and physical processes involved in cellular activities, the apparent need for a life force waned, and "vitalists" or "animists" were vilified. In modern reductionist science the notion of life force or energy or information field has remained almost taboo. However, a new wrinkle has recently appeared. Whereas nineteenth-century vitalism was based completely on forces outside the realm of science, a "vitalist" perspective has emerged in which life derives by direct extension from the most fundamental level of reality. In "quantum vitalism", life is intimately linked to self-organizing processes at the most basic level of the universe".

3. Logical Incompleteness and Soul

The appearance of life is therefore programmed in the elementary particles of the universe, and this implies a set of laws using chance and putting it into effect in the only possible way, comprising an immaterial psychic field. In the course of evolution this field accompanies matter up to complexity and freedom. In this hypothesis it is worth noting that evil and pain would be due directly or indirectly to psychic causes, both at the level of the blind calamity produced in the action of a rudimentary psyche and at the higher level of the free action of consciousness.

Be that as it may, we must realize that when we appeal to chance in nature we cannot escape identifying it with a framework of *physical* acausality, within which we happen to find creativity, novelty, and freedom and, along with these, calamity.

In an essay published in 1967, the theologian Rahner had this to say about the presence of spirituality in matter in the course of evolution:

"If effectively the process of becoming is really one of self-transcendence which, depending on the circumstances, can go so far as to yield a new essence [...] and if matter and spirit are not simply disparate entities, but matter is somehow a frozen spirit ("frigorifié"), the only meaning of which is to make the spirit proper possible, and if, lastly, created spirituality always remains spirituality in matter up to its absolute realization, then the evolution of matter into spirit is not an unrealizable concept, provided only that the concept of evolution is understood in the sense of this essential self-transcendence subject to the dynamism of the absolute being."

This opinion, which is shared by others, opens up a vast horizon in natural philosophy, which to-day addresses the study of evolutionary processes, including biological and psychological ones, with new conceptual instruments, such as the theories of complex systems, self-organization and emergent properties. Animated beings distinguish themselves particularly in that they are capable of autonomous activity (self-movement) and, in the case of human beings, in their consciousness, power of abstraction, of constructing forms and grasping universals, in their freedom to choose and causing effects which cannot be explained solely on the basis of neuronal behaviour. The emergent properties in the course of cosmic evolution, particularly life and consciousness, as such (i.e. *qua* emergent), would appear to come from nothing. When Rahner talks about the evolution of matter toward spirit and indicates the way it comes about, i.e. "self-transcendence", what he means is that the emergence does not come from nothing, but comes into being as a *form contained potentially in things and actuated in adequate causal conditions*. This, as well as other forms, are known philosophically as degrees of being. These include the human soul as the only full ontological emergence of the "image and likeness" (*Gen 1, 26*), the last rung of a ladder whereby the psychic potentials of nature gradually manifest themselves. This line of thought is shared and clearly expressed by the theologian Ratzinger (1985) in his *Carinthian Lessons*:

"... spirit is not added to matter as something extraneous [...]; rather its coming forth denotes that a movement which makes use of an outrider arrives to destination. Finally, we should say that



the creation of spirit is just what less than anything else could be represented as a handicraft of God, who should have begun hereabouts, suddenly, to bustle in the world”.

Within such a perspective, different from that of Thomistic philosophy, it is easier, notwithstanding the difference, to comprehend the anthropological view of spirit and matter as constitutive principles of one being, that is, one substance (Fabro, 1979; Ocariz, 1979). One can then admit that the soul is an emergent property potentially present since the beginning of cosmic evolution but one which (Musso, 1977)

“...is actuated, triggered as Searl puts it, only in the presence of certain conditions, i.e. of a certain level of organization [...] that is to say, a real leap forward in ontological level – well, in this case it is possible that such an event may occur several times in the course of evolution, at different levels and also with different outcomes, with a gradual growth of its own powers and its own independence from the material substrate [...]; this therefore paves the way for a truly non-reductionist explanation of unconscious life, as well as of those intentional behaviours we may well encounter, albeit in attenuated form, in species other than our own. [...]

If the very laws of nature oblige us to admit the existence of phenomena that they cannot explain, and consequently to postulate that they are grounded in a different, non-material type of reality, it would be simply contradictory to claim that the related causal powers cannot be attributed to them for the reason – or rather the tautological argument – that they cannot be explained in materials terms”.

Why the conscious free choice, which our *Ego* is able of, could not be made by an exclusively material agent, whether part of deterministic or of indeterministic systems? Beside the thermodynamic problem, as we said above, in the first case it is unimaginable that a rigid causal set might give free scope to anything outside its own laws, and in fact those who identify psychical and cerebral states, Crick for example (1994), are often inclined to consider as an illusion, in spite of its immediate evidence, the interior sensation of freedom; in the second case, our choices cannot be but the result of quantum events carried out with casual arbitrariness, since indetermination implies constant fluctuations, also in the absence of any measuring operation. Not even by means of the dynamics of non-linear systems (chaos), notoriously active in the brain, could this autonomously make a choice and cling to it,

because of the typical instability of chaotic dynamics. The indeterministic aspects of matter, which are also present in neurons, are just those that justify the *possibility* of a causal action of the soul on the brain without violating the laws of physics (Eccles, 1990; Beck and Eccles, 2003; Hameroff and Penrose, 1996).

The human psyche is much more than a computer. It was to Gödel's credit that he explained, as early as 1931, his “incompleteness theorems”, accepted since then by all logicians. The first theorem states that for logics higher than that of first order predicate calculus, in every logico-mathematical system which is coherent there are propositions that cannot be demonstrated within the system, but that we can see to be true. The consequence was to take note in the mathematical spheres of the difference of the concepts of demonstrability and truth, and of the impossibility of deriving all truths with mechanical procedures.

For any rational system founded on axioms and rules of logical inference, and coherent, it has been proved that there are infinite truths which are not demonstrable within the system. Therefore, the set of demonstrable propositions is not coincident with that of true propositions. “Gödel seems to give back to the human mind, fit for abstraction and hence able to get out of the system, a status quite different from that of any machine, unable to be self-conscious.” (Bertelè *et al.*, 1999). A detailed exposition of the theorems cannot be made here: the demonstration requires the prior analysis of 46 propositions and 5 preparatory theorems. Let us try to grasp knowledge by intuition;

1. Among the infinite truths not belonging to whatever consistent axiomatic system A, one of these truths is represented by the statement G which, within A, is equivalent to the following assertion: “G is not a theorem of A”. Now we can ask: is statement G true? If it is false, then it is a theorem of A, and then A is an inconsistent system. Therefore, G must be true, not a theorem of A, not provable within A. If A is consistent, G is not a theorem of A. But this is what G asserts, so G is true. Consequently, there are true propositions which are not demonstrable.

2. It has been said in A that “if A is consistent, G is not a theorem of A”. This proposition contains the theorem “A is consistent” and the theorem “G is not a theorem of A”, i.e. in



this proposition G should be just what it states not to be. But then the entire proposition, and particularly the first part (the theorem “A is consistent”) cannot belong to A, if A is consistent; namely, if the system is consistent, it cannot prove its consistency.

It has been shown that the first theorem is valid for all consistent formal systems, which are therefore incomplete, that is to say, there are formulas that are not demonstrable in them and that we, *standing outside* the system, can see as truths: our intellect is not confined within the limits of the rational system.

Gödel’s theorems must apply to cybernetic machines, since it is quality and essence of their own to consist of concrete installation of a formal system. Therefore, for a machine (computer) able to manage arithmetic, and coherent, there will always be a formula which cannot be demonstrated in the machine-system but which we can see to be true. In other words, no machine will ever be an adequate and complete model of the human soul, whose essence is different (Lucas, 1961).

The importance of Gödel’s theorems and of others which followed on the argument may be defined as epochal. According to Chaitin (2006), Gödel discovered just the tip of an iceberg of mathematical incompleteness which concerns an infinite number of theorems which are true but cannot be demonstrated by any finite system of axioms. Certain mathematical facts are true without any logical reason, and it is impossible to find a theory explaining why they are true: they are irreducible not only from a computational point of view, they are logically irreducible, and can be used solely as axioms. A theory is useful if it represents an algorithmic compression of data: comprehension is compression, which in many cases is unrealizable because one is in front of an irreducible complexity. The example which can demonstrate these limits of logical knowledge is the number that Chaitin has called “omega” and which indicates the probability of halting a computer program chosen by chance among all other possible programs. It is a number which possesses a definite value but one that will never be calculated because the number is irreducible.

These theorems have definitively proved that for any logical system there are infinite truths which are not demonstrable in it, but the human intellect sees them just as truths. It is also evident

that the truth does not allow itself to be denied (Poppi, 1984): “... truth does exist necessarily, is indefectible, cannot be denied without re-proposing in the negation itself.” And it proves itself as “indubitable truth of doubt”, as Augustine said (*De vera religione* 39, 73): “Anyone who understands to be in doubt sees something that is sure (his doubt), which he is certain of. Therefore, he is certain of a truth.” Much of the above discussion is synthesized by Augustine (*De Libero Arbitrio* II,12,34) in a few words: “...we judge our knowledge by means of truth, but we cannot pass judgement on truth itself. [...] Do not get out of yourself, [...] it is inside man that truth abides.”

In fact, in our inward world we can also find beauty, good, morals... and we see that good is truth, which makes us free. According to Maritain (1973);

“...human intelligence, although being a reason that manages its concepts, observant of logical rules (and this depends on its carnal condition) is also an intellect, that is a power able to see in the intelligible order as the eye does [...] in the tangible one. The intellect knows the prime principles of any demonstration just through such an insight.”

Berlucchi (2012) in the essay *Mente e Cervello (Mind and Brain)* develops interesting considerations. He uses the term “mind” to indicate a cerebral function, and “soul” to denote a supposed “immaterial essence” (which should be left to metaphysical discussions). In the conclusions he recalls the new ways of intending the active role of conscience and will “in the control of cerebral operations, breaking the apparent causal closure of the physical world”. Mental states are seen as emergent properties of cerebral processes, and that in their turn exert an inverse causality on cerebral matter (top-down, as is typical of complex systems).

If we conform to these indications and terminology, and to what has been said in the preceding pages about causality in the physical world, we shall put the boundary line of the dualism *truth / demonstration* at the level of and as the expression of *soul / mind*. Thus we speak of emergent dualism: intellect and reason, freedom and mechanisms, truth and demonstration, soul and mind; but one intended as the composition of the substantial unity of informed matter constitutive of man. On this subject, Basti (1995) appropriately quotes a passage of Thomas Aquinas where a qualitative distinction is lucidly made between cognitive operations. In fact,



although apparently all of them are equally peculiar to the body-soul compound, they are not: for example, the intellective act which leads to an abstract conception absolutely lacking in physical models cannot be but spiritual. This is why we say that the soul is also a subsistent form, in possession of autonomous being, because it accomplishes operations independent of the body. "The thesis of the subsistence of the human soul, together with the thesis of the intellective soul as the only substantial form of the body, is conclusive in the construction of an anthropology..." (Ghisalberti, 2012).

What do we intend while speaking of intellect, or in other words, which relation exists between knowledge of truth and possession of freedom? To have freedom, syntax is not enough, what is needed is semantics, which makes the difference between human intelligence and that of animals and artificial intelligence. Animals lack the concept of logical connexion, and so cannot distinguish induction from deduction, nor can they understand why some sentences are proofs of others (though in point of fact they can make use of acts of logical succession and therefore operate deductively); moreover, lacking the concepts of true and untrue, they cannot refuse an argument raising an objection to the previous statements (Swinburn, 1986). Leibniz (*Monadologie* 29) wrote: "It is the knowledge of necessary and eternal truths that distinguish us from animals, [...] letting us know ourselves and God."

So there is a difference between the knowledge of man and animals, a difference which expresses an ontological emergence whereby what is meant as 'soul' cannot be reduced to the meaning of 'mind' or 'brain'. But even between emergentists there are strong differences. Searle (1992) stated that consciousness is an emergent property of brain in the sense, for instance, in which solidity is a property of water molecules when they are frozen. But, if solidity is a property which may be taken back to the behaviour of molecules, consciousness attributed solely to cerebral states cannot be an ontological emergence, and in fact Searle asserts that cognitive phenomena are simply caused by neurophysiological processes of the brain, which however cannot exhaust all the non-reducible emergent reality. Sperry's emergentism (1976) is more radical, considering mental properties as "configurational and olistic", different from the neural events of which they are composed but

upon which they exercise a regulative control: mental events are causes rather than correlates.

To have freedom, both the form of knowledge (noësis) and the related substantial substratum must be distinct respectively from the logic (diánoia) and from the computer. According to Wojtyła (1980): "Man is objectively *somebody* and in this consists what distinguishes, in the visible world, him/her from the other beings, which are always *something*." The difference cannot but be self-possession that qualifies the person, and hence the human soul. But there are still discordant ways of understanding what the soul is (Berti *et al.*, 2004). A psychiatrist deeply resolute in his "scientific atheism", Debray-Ritzen (1974), wrote of his soul: "... a computer with its fifteen billion transistors and its umpteen billions of connections, in which a unique intellectual and emotional personality has formed...; the assembly of all this on a single tool... is my soul."

3. Truth and Provability

A computer is an instrument capable of performing operations in terms of *demonstration*, and the problem of mind/soul can be approximated only if we clarify the relationship between demonstration and truth. We shall try to examine this through what the soul itself expresses, i.e., natural language, in which they are actually found in a non-pacific coexistence.

The conflict is classically expressed by "the antinomy of the liar", a well-known paradox representing an obstacle to the definition of truth in natural languages. Imagine (Tarski, 1956, 1969) a book of many pages, each containing only one sentence. On page 1 we read: "The sentence written on page 2 is true"; on page 2 we read: "The sentence written on page 3 is true"; and so on, up to the last page of the book where we read: "The sentence printed on page 1 is false." Assume that the sentence of page 1 is indeed false: confronting what it says of the following sentence and all the ensuing ones, we must conclude that the sentence printed on page 1 is true in so far as it arrives at confirming the statement of its own falsity, namely it is both true and false. Assuming on the contrary that the sentence of page 1 is true, the conclusion is the same. A number of logical antinomies are known, inducing contradictions. We must take note of a common condition and cause of them: it is the superimposition of the concept of *truth* upon



a system of declarative sentences which pertain to *provability*.

He who does not recognize this point will expect to exhaust truth in the provability, so as to proceed in the certainty of exact science, but excluding a priori from his knowledge infinite truths (Gödel's incompleteness); those who acknowledge that a system, in which antinomies appear, denounces a symptom of disease, will not found their knowledge on methodological bases that reveal contradictions, but will go deep into the question with scientific rigor. The exposition which follows traces back to Tarski.

If we analyses the characteristic elements of language that are the real source of the antinomy of the liar, a fundamental aspect of common language strikes us: its universal, all-inclusive character. In particular, it is possible to ascertain that, for each sentence of the common language, it is possible to formulate in the same language another sentence which declares that the first one is true or false. Such universal languages involving logical antinomies are neither necessary nor suitable for the aims of science. For example, in chemistry, certain particular objects are studied (atoms, molecules, etc.) and not others: the vocabulary of the theory is meagre, the language suitable for the treatment of this subject is therefore a restricted one. The conditions imposed on the language in order to secure its coherence are that the vocabulary must be completely determined, that precise formal syntactic rules are used, and that this limited language is kept distinct from that in which the notion of truth is used, its definition is formulated, and its implications are discussed. The latter will be called "metalanguage" and the former "object-language"; the metalanguage must be richer than the object language, since it must contain all of the set of sentences of the object-language, which have to be available for the definitions of truth. The exclusion of the definition of truth from the object-language or, in other words, the distinction of the notion of truth from the system of provable sentences, results in being a radical condition to avoid antinomies, that is, for a correct foundation of logic. Important deductions can be made.

Let us take for example as an object-language that of arithmetic. The vocabulary is very limited, including variables, numbers, symbols for relations and operations on numbers, and some logical terms and simple rules. The metalanguage will be that in which the theory for the study of

arithmetical language is formulated (meta-arithmetical), and it will contain the definitions of truth and of provability. We can therefore define in the metalanguage the set of provable sentences of the arithmetical language, that is the set of its sentences which satisfy the definition of formal proof. It will also be possible to arrange all provable sentences in order of complexity, and number them. So it will also be possible to describe the relations between the numbers assigned to the sentences by means of arithmetical operations and relations, that is in the object-language itself. Since the set of numbers corresponding to provable sentences can be described in arithmetical terms, it might be said that the definition of provability is translatable from the metalanguage into the object-language.

No such translation can be obtained for the definition of truth, otherwise the logical antinomies would reappear, because the object-language would again turn out to be universal. All this means that the set of provable sentences and the set of true sentences do not coincide, since one of them does not enjoy all the properties of the other (to show that two data sets are not coincident it is enough to indicate one property of one of them not shared by the other). All the axioms of arithmetic being true and all rules unailing, all the provable sentences must be true. In view of the non-coincidence of the two sets there must be true sentences that are not provable, just as Gödel said.

It is well known that a computer is constructed in such a way as to operate with certain axioms and formalized logical rules, thus obtaining any number of proved sentences. We can define these sentences as true if we place our trust in the axioms and rules of logic, and we would be tempted to consider the logical sum of the provable sentences as the definition of truth of the computer. Here, however, we run up against the problem of antinomies. The word "truth" and any discussion of it must be excluded from the object-language if we wish to keep it free of antinomy. Thus the notion of truth must be distinct from the system of provable sentences, and therefore distinct from the computer.

The soul, according to Debray quoted before, and many others, is a kind of computer, a "tool", but it embraces in its language, besides logical expressions, also semantics and truth which are metalogical. We must therefore be

aware of what is clearly present in our universal language: a dualistic expression.

An essential point is this: any logico-mathematical system requires a non-logical foundation of axioms. Stegmüller (1969) states that it is impossible to disprove the essential intuitions without having just presupposed them. We can't help establishing our conceptual intuition that permits us to catch the relation between abstract concepts, a type of eidetic evidence. The evidence is warranted by our capacity for intuition of essences (Galvan, 1992). Similar opinions are expressed by Penrose (1989): "ability to divine or in the truth from falsity" and also "aesthetic criteria"; and by many others.

Some people claim that the paradox of the liar (*Epimenides' paradox*) owes its absurdity to the fact that it is an operation of self-reference. As Galvan says, "...against a certain reasoning aiming at some demonstration of senselessness of Gödel's theorem because of its self-reference, hence circularity, [we must make clear that] the formula is certainly self-referential but not senseless as it isn't circular." Hofstadter (1969, 1981), on the other hand, furnishes the demonstration of the reproduction of Epimenides' paradox in the Typographical Theory of Numbers, as operated by Tarski, whereby we have a version of the paradox which, at this level, becomes not an affirmation about itself but a sentence about numbers which is true only if it is false. A possible explanation offered by Hofstadter himself, namely the hypothesis that the antinomy could derive from an inconsistency between cerebral functions, would discredit rationality and make our arguing useless, and the author himself obviously confirms that when in a logical system even only one contradiction is allowed, then, from the principle *ex falso quodlibet*, anything may be deduced within that system. The metalogical notion of truth becomes instead a reliable guidance for the rationality in the dualistic hypothesis, since in this case the reason rests eventually on absolute truth. After all, Hofstadter's hypothesis is but another way of saying that the burden of truth cannot be given to rational thinking without having to pay the penalty of paradoxes.

It may be interesting to note how, generally, self-reference can introduce a paradox when the reference is made through the semantic content of the proposition itself. These paradoxes depend ultimately on the conflict between two radically different modes used in language to consider the

identity of a being, namely, on the one hand identity defined by means of spatio-temporal (or logico-formal) localization, for a concrete entity and on the other, identity independent of any related space-time domain and possessing a semantic nature, for an abstract entity such as, for instance, a quality. Entities of the former type are necessarily designated by means of substantives, while those of the second type, corresponding to qualities, may be designated by means of adjectives (e.g. true). This being so, the operation of identification on a semantic basis is alien to the computer and to calculating thought, for which self-reference through the semantic content is prohibited. In other words, qualities, perceived in their semantic identity, have to be kept distinct (metalanguage) from the language and operations of quantitative logic (object-language) and spatial identification, and therefore distinct (dualism) from the subject of action to which the latter operations pertain. This dualism is the reason for the difference which exists between truth and proof and, in general, between perception of *quality, essence and form* on the one hand, and *res extensa* on the other.

The advocates of artificial intelligence very often neglect the dual aspect which we have dwelt upon here at some length, identifying all intelligence with logic. On the basis of what has been said, this can only be a blind alley, up which people go when they are unwilling to accept the dualistic solution. The materialistic axiom on the ground of which all knowledge must form part of physical sciences thus does not allow us to rely on its certainty. K. Popper and many others have condemned any dialectic metaphysics in which the use of contradiction is permitted, albeit within some limits. He who declares that "... one can live in contradictions and be happy" should show a consequent behaviour. On the contrary, when the occasion occurs, he will do no such thing as to throw himself into a well, convinced, as Aristotle said (*Metaphysica, IV*), that to fall down is not at all the same thing as not to fall.

When Debray, quoted above, says "...my soul is unique because the chromosomes which contributed to the formation of my body contained an absolutely original message", what he is saying is right, but incomplete. Aristotle had already established that living beings are composed of matter and information (as confirmed by the data of modern biology to which Debray refers) and had reached the conclusion that from this point of view there can be no subsistence of the soul



outside informed matter. Aristotle, however, also recognized the existence of the “noūs”, i.e., of the intellect capable of exercising contemplative cognition, which “appears to be a different type of soul, [...] susceptible of being separated, like the eternal, from the corruptible.” The perception of “that which is with regard to essence” is therefore proper to the noūs, capable of the cognition corresponding to semantic identification which, not being a form of discursive-propositional thought, can get in touch with the timeless (Aristotle, *De Anima*, II,1,413a).

One absurd consequence of identifying the soul with the computer, and of the failure to distinguish between truth and proof, is reported by Sutherland (1981) in a commentary on a book by McKay (1967). The latter, distinguishing between hardware and software in the brain, suggests that one possible solution to the problem of resurrection might consist in the incorporation of the program operating in the brain of each individual into something other than the human body. Furthermore, he ventilates the hypothesis of constructing computers which are as intelligent as the individuals of the human species and which, Sutherland observes, could therefore be legitimate candidates for the Kingdom of Heaven. As outlined above, the software of calculating thought is characterized by incompleteness and does not see infinite truths. Freedom, creativity and truth abide elsewhere, since it is evident that, if human actions would be simply connected to strict mathematical inferences and to rationality, they should be always foreseen.

We should try to explain such points to those who state that there are arbitrary limits to their own knowledge, for instance defining themselves as “Atheistic and Agnostic Rationalists”, without taking great account of how many times they put their faith in so many axioms which are not subject to proof. Supposing that God’s existence is not a possible subject of investigation by the rational method, the agnostic attitude seems to be correctly defined as “rationalism” from a logical point of view. The

position of atheists is different in so far as they presuppose that something not subject to proof is non-existent. It is rather difficult to understand why all of them go together.

But a question can be asked, perhaps an impertinent one: is their method the only well-grounded one to provide a complete knowledge of existent reality? Clearly, what is in question is the method. If it were the very method to be followed to get knowledge, then we should use such a method, of which the field is under discussion, also to determine the field of the method itself. He who declares himself to be an atheistic rationalist shall grant a fall in a circular argumentation or make an act of faith.

Man has been defined along the centuries as a “rational animal” for example by Plato, Aristotle (though considering the intellectual intuition as a higher function), Plotinus, Cicero, Sallustius, Augustine (*rational substance made of soul and body*), Boetius (*rationalis naturae individua substantia*), Aquinas (*intellectus et ratio*), Scotus, Occam, Descartes (*res cogitans*), Hobbes (*mechanism with rational soul*), Spinoza, Locke, Leibniz, Kant, Hegel... But the definition is inadequate: man is not only a rational animal, he is an animal able (sometimes) to recognize the limits of his own reason. As we have seen, knowledge requires not only reason but also intellect, logos and myth, “*denken*” and “*dikten*”: if man doesn’t have the humbleness to recognize the limits of his own reason, he will not exhaust truth, nor, therefore, be really free.

Man can profit by his freedom to do good and evil thanks only to indeterminism, the physico-mathematical incompleteness of chaos and the logico-mathematical incompleteness of Gödel’s theorem, that is to say, on the other side, to cosmic pain: these properties of matter also bring about calamities and suffering to be considered as the great price that nature and man have to pay for their creativity and freedom (Zatti, 1993; 2014).

References

- Antiseri D. Gloria o miseria della metafisica cattolica italiana? Armando, Roma, 1987; 31.
- Argonov VY. Neural Correlate of Consciousness in a Single Electron: Radical Answer to Quantum Theories of Consciousness. *NeuroQuantology* 2012; 10 (2): 276-285.
- Basti GF. Filosofia dell' uomo. ESD, Bologna, 1995; 351.
- Beck F, Eccles JC. Quantum Processes in the Brain: A Scientific Basis for Consciousness. In: *Neural Basis of Consciousness*. Osaka N. Ed. Benjamins, Amsterdam, 2003; 141-166;
- Berlucchi G. Mente e Cervello. In: *L'anima e la mente*. Andreoli V, Buzzi F. Eds. San Paolo, Cinisello Balsamo, 2012; 137-47
- Bertelè F, Olmi A, Salucci A, Strumia A. Scienza, analogia, astrazione. Il Poligrafo, Padova, 1999; 251-265.
- Bohm D. Wholeness and the Implicate Order. Routledge, London, 1980.
- Boncinelli E. Quel che resta dell'anima. Rizzoli, Milano, 2012; 137.
- Born M. Natural Philosophy of Cause and Chance. Clarendon Press, Oxford, 1949.
- Chaitin G. The Limits of Reason. *Sci. American* 2006; 294 (3): 54-61.
- Chalmers DG. Facing up to the problem of Consciousness. In: *Toward a Science of Consciousness*. Hameroff SR, Kazniak W, and Scott AC. Eds. MIT Press, Cambridge MASS, 1996; 5.
- Cho A. Physicists Create Quantum Link Between Photons That Don't Exist at the Same Time. *Science NOW*, 22 May 2013.
- Crick F. The Astonishing Hypothesis: The Scientific Search for the Soul. Simon and Shuster, London, 1994.
- Cusano N. La dotta ignoranza. [1440] Città Nuova, Roma, 1998.
- D' Espagnat B. On Physics and Philosophy. Princeton Univ. Press, 2006.
- Darwin C. The Descent of Man. [1871] Prometheus Books, Amherst, New York, 1998; 11.
- Davies PCV, Brown JR. The ghost in the atom. Cambridge Univ. Press, 1986.
- Davies PCV. The Mind of God. Simon and Schuster, London, 1992; 192-193.
- Debray-Ritzen P. L'ateismo scientifico: uno psichiatra. In: Chabanis C. Dio esiste? No, rispondono. Mondadori, Milano, 1974; 127.
- Doyle R. Free Will: The Scandal in Philosophy. Information philosopher, 2011.
- Eccles JC. A unitary hypothesis of mind-brain interaction in the cerebral cortex. *Proc. Royal Soc. London B* 1990; 240: 433-451.
- Ekeland I. La matematizzazione del caso. In: *Aggiornamenti sull'idea del caso*. Noël E. Ed. Bollati Boringhieri, Torino, 1992; 171.
- Ellis GFR. Physics, complexity and causality. *Nature* 2005; 435: 743-745.
- Ellis GFR. Physics and the Real World. Metanexus Institute, Science and Religion: Global Perspectives, 2005; Philadelphia, PA, www.metanexus.net
- Fabro C. San Tommaso davanti al pensiero moderno. In Livi A, Fabro C, Ocàriz F, Vansteenkiste CMG. *Le ragioni del Tomismo*. Ares, Milano, 1979; 50: 96-160.
- French AP, Fennedy PJ. Niels Bohr: A Centenary Volume. Harvard Univ. Press, Cambridge MASS, 1985; 101-120.
- Galvan S. Introduzione ai teoremi di incompletezza. Franco Angeli, Milano, 1992; 191-202.
- Gao S. A possible quantum basis of panpsychism. *NeuroQuantology* 2003; 1(1): 4-9.
- Gao S. The Basis of Indeterminism. *Phil Sci Archive* 2001, <http://philsci-archive.pitt.edu/documents>.
- Ghisalberti A. L'anima da Aristotele a Tommaso d'Aquino. In: *L'anima e la mente*. Andreoli V, Buzzi F. Eds. San Paolo, Cinisello Balsamo, 2012; 35-36.
- Gödel K. *Collected Works*. Feferman S. Ed. Oxford Univ. Press, New York, 1986; 1: 145-95.
- Gribbin J. *In search of Schrödinger's cat*. Corgi Books, London, 1985.
- Hameroff SH, Penrose R. Orchestrated reduction of quantum coherence in brain microtubules: a model for consciousness. *J Consciousness Studies* 1996; 3: 36-53.
- Hameroff SH. Quantum Vitalism. *Advances* 1997; 13: 13-22.
- Hofstadter DR, Dennet DC. *The Mind's I*. Basic Books, New York, 1981.
- Hofstadter DR. Gödel, Escher, Bach. Basic Books, New York, 1979; 449-50.
- Krips H. *The metaphysics of quantum theory*. Clarendon Press, Oxford, 1987.
- Kuhlmann M. What Is Real? *Sci American* 2013; 309(2): 32-9.
- Leibniz GW. *Scritti filosofici*. [1666-1714] UTET, Torino, 1967.
- Lucas JR. Minds, Machines and Gödel. *Philosophy* 1961; XXXVI: 112-27.
- Maleeh R, Amani P. Bohm's Theory of the Relationship of Mind and Matter Revisited. *NeuroQuantology* 2012; 10(2): 150-163.
- Maritain J. *Il contadino della Garonna*. Morcelliana, Brescia, 1973; 166.
- Masolo C, Oltramari A, Gangemi A, Guarino N, Vieu L. La prospettiva dell'ontologia applicata. *Rivista di estetica* 2003; 22: 170-183.
- Maxwell JC. *Theory of Heat*. [1871] Dover, New York, 2001.
- McKay DM. *Brains, Machines and Persons*. Eerdmans, Grand Rapids MI, 1980.
- Megidish E, Halevy A, Shacham T, Dvir T, Dovrat L, Eisenberg HS. Entanglement Between Photons that have Never Coexisted. *Phys Rev Lett* 2013; 110: 210403.
- Monod J. *Le hazard et la nécessité*. Seuil, Paris, 1970; 86-98.
- Musso P. *Filosofia del Caos*. Franco Angeli, Milano, 1977; 174-75.
- Ocàriz F. *Il Pensiero di San Tommaso*. In: Livi A, Fabro C, Ocàriz F, Vansteenkiste CMG. *Le ragioni del Tomismo*. Ares, Milano, 1979; 96-160.
- Penrose R. *The Emperor's New Mind*. Oxford Univ. Press, 1989; 110, 412, 421.
- Penrose R. *The Large, the Small and the Human Mind*. Cambridge Univ. Press, 1997.
- Philippi CL, Feinstein JS, Khalsa SS, Damasio A, Tranel D, Landini G et al. Preserved Self-Awareness Following Extensive Bilateral Brain Damage to the Insula, Anterior Cingulate, and Medial Prefrontal Cortices. *PLoS ONE*, 2012; 7(8): e38413 doi:10.1371/journal.pone.0038413
- Popper KR, Eccles JC. *The Self and its Brain*. Springer, New York, 1977.
- Popper KR. *Società aperta, universo aperto*. Borla, Roma 1984; 102-109, 133.
- Poppi A. *La Verità*. La Scuola, Brescia, 1984; 95.
- Rahner K. *Science, évolution et pensée chrétienne*. Desclée De Bouver, Paris, 1967; 111.
- Ratzinger J. - Benedetto XVI. *Progetto di Dio*. [1985] Marcianum Press 2012, p 133. According to M. Heller (The New Physics and a New Theology. Libreria Editrice Vaticana, 1996.
- Ratzinger J. - Benedetto XVI. *Progetto di Dio*. [1985] Marcianum Press, 2012; 134.
- Searl JR. *The Rediscovery of the Mind*. MIT Press, Cambridge MASS, 1992; 127-129.
- Sperry RW. *Mental Phenomena as Causal Determinants in Brain Function*. In: *Consciousness and the Brain*. Globus www.neuroquantology.com



- GG, Maxwell G, Savodnik I. Eds. Plenum Press, New York, 1976; 163.
- Stegmüller W. *Metaphysik*. Springer, Berlin-Heidelberg-New York, 1969.
- Sutherland S. *Science and Faith in Mind*. Nature 1981; 290: 167.
- Swinburne R. *The Evolution of the Soul*. Clarendon Press, Oxford, 1986; 210.
- Szilard L. *Über die Entropieverminderung in einem Thermodynamischen System bei Eingriffen Intelligenter Wesen*. Zeitschrift für Physik 1929; 53: 840-856.
- Tarski A. *Logic, Semantics, Metamathematics. Papers from 1923 to 1938*. Clarendon Press, Oxford, 1956; VIII: 152-278.
- Tarski A. *Truth and Proof*. Sci. American 1969; 220: 63-77.
- Teilhard de Chardin P. *Le phénomène humain*. Seuil, Paris, 1955; 335.
- VVAA. *L'Anima*. Berti E, Ivaldo M, Mura G, Possenti V. Eds. Mondadori, Milano, 2004.
- VVAA. *Mental Causation and Ontology*. Gibb S, Lowe EG, Ingthorsson RD. Eds. Oxford Univ. Press, 2013.
- Weinert F. *Quantum mechanics: The Physicist turns Philosopher*. Conference Proceedings of 100 Years Quantum Theory, Madrid, 2000. <http://www.staff.brad.ac.uk/fweinert>
- Whitehead AN. *Adventures of Ideas*. Macmillan, London, 1933.
- Wojtyła K. *Amore e responsabilità*. Marietti, Casale Monferrato, 1980; c.I.
- Wurzman R, Giordano J. *Mind, matter, neuroscience and physics*. NeuroQuantology 2009; 7(3): 368-381.
- Zatti M. *Anthropic Biology*. In: *The Anthropic Principle*. Curi U. Ed. Cambridge Univ. Press, 1993; 129-142.
- Zatti M. *Il dolore nel creato: un disegno intelligente?* Rubbettino, Soveria Mannelli, 2013.