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On the Methodology of Physics: Cognizing Physical Phenomena and the Genesis and Termination of Time

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The methodology of physics is discussed. The limitations of the empirical method are exposed, and it is argued that these limitations are related to our sensory input. The limitations of mathematics and of the representation of physical theories by mathematical models are also examined. An alternative methodology, the establishing of physical models on neuropsychology, is suggested and demonstrated. A cognitive psychological model of the genesis and the termination of time is explored.

Keywords: neuropsychology, multidimensional time, annihilation of matter and antimatter

Cognition is performed by the cerebrum which is composed of two hemispheres, each having a somewhat different cognitive role than the other. One of the tasks of the cerebrum is to perceive the empirical phenomena that occurs in the physical world. Another task performed by the cerebrum is mathematical cognition. These two tasks are related to the approaches to physics: the empirical and the mathematical. We will analyze the performance of these two tasks by the cerebrum and its hemispheres and their role in the cognition of physics. A third approach to physics is suggested, which is to determine in advance what the cognitive models of the physical world are that our cerebrum can possibly cognize and apply this knowledge as a guide in our search for empirical facts and their mathematical description.

The Hemispheric Mechanisms

The goal in this study is to understand human cognition, in particular the cognition of mathematics, of physics, and the relation between them. The theoretical

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instrument which we will apply is the hemispheric paradigm. This instrument explains successfully all these subjects.

We apply the model of Ben Dov and Carmon (1976). According to this model the human brain includes two neural mechanisms related to cognition that are partly lateralized to the two cerebral hemispheres. The two mechanisms operate in successive stages. The first mechanism is partially lateralized to the left; therefore we will call it "the left hemispheric mechanism." It processes data analytically, one item after another temporally. Then the left hemispheric mechanism transfers the processed data to the second mechanism, which is partially lateralized to the right and will be called "the right hemispheric mechanism." It integrates several individual items into a new comprehensive whole, presents this whole simultaneously in space, and transfers it to the left hemispheric mechanism. The left hemisphere treats this whole as a new individual item, and transfers it back to the right hemisphere. Then several such comprehensive items are integrated into a newer, more comprehensive item. Thus more and more complicated cognitive structures are created.

An example of this process is reading. The left hemispheric mechanism reads one letter after another temporally and transfers the letters to the right hemisphere, where they are integrated into a word that is perceived simultaneously in space. Then the word is transferred to the left hemisphere where it is treated as an individual item, and it is transferred to the right hemispheric mechanism. The right hemisphere integrates a sentence out of several words, and transfers it to the left one, and so on.

Ben Dov and Carmon (1976) suggested that the same sensory data are presented to both hemispheric mechanisms. Therefore time and space are no more than modes in which the left and right hemispheric mechanisms, respectively, present the output of their processing to consciousness. Ben Dov and Carmon argue that this means that time and space are subjective, and relate this conclusion to Kant's idea that time and space are our subjective modes of perceiving experience.

Potential infinity, the occurring of a series of events one after another temporally, without a last one, is related to the left hemispheric mechanism. On the other hand, the integration of all the elements participating in a potentially infinite process into the simultaneously and spatially presented actually infinite set of all these elements is performed by the right hemisphere (Fidelman, 1987a, 1987b, 1988a, 1992).

Zeno's Paradoxes and Descartes' Argument

The idea that the extension of time towards the past is finite is an ancient one, and its roots are the theological idea of "creation." It was suggested by Descartes (1641/1986, Third Meditation, pp. 28–29) that "something cannot arise from nothing," namely, everything (an idea or an object) has a cause. Thus

a chain of causes exists. However, "there cannot be an infinite regress here; eventually one must reach a primary idea, the cause of which will be like an archetype which contains . . . all the reality . . . ." According to Descartes this primary cause is God.

Kant (1781) extended Descartes' argument and provided the following proof that the cosmos cannot exist in infinite time. If the cosmos had existed an infinite period in the past, then for each event there is another event that precedes it in time. Thus there is a potentially infinite series of events preceding each other without a first event. This causes a cognitive paradox: How it is possible that an infinite series of events (without a first event) that never began, is terminated in the occurring of a certain event in the present? This argument may be applied (by inverting the direction of time and the order of the events) to prove that time cannot be infinite also towards the future, and therefore there is an end of time within a finite period in the future. While Descartes applied this argument to prove that the world has been created before a finite period of time, Kant used it as a part of a proof that time is neither finite nor infinite, and therefore it can exist only in our consciousness.

This argument of Descartes and Kant originated in Zeno's paradoxes of the runner and of Achilles and the tortoise against the existence of continuous motion. A version of Zeno's runner paradox is: a runner that runs from a point A to a point B can never arrive at his destination B, or even depart from the starting point A. Before the runner arrives at B he must pass half of the distance and before this he must pass a quarter of the distance, and so on, without a first step. Therefore the runner can never begin his running. Even if the runner could start the running, he cannot reach the target. Before reaching the target the runner must pass half of the distance between A and B; then the runner must pass an additional quarter of the distance, and so on, without a last step. This potentially infinite process without a last step cannot terminate, and the runner does not reach the target B. Zeno's argument is that a potentially infinite process cannot be completed; therefore every process must terminate after a finite number of steps.

As stated above, the potentially infinite series of events (each one of which is caused by the previous one) without a first event, is cognized by the left hemisphere. On the other hand, the termination of this process by arriving at a finite or infinite limit (which is related to the integration of all the steps of this process into actual infinity) is performed by the right hemispheric mechanism. Nevertheless, Zeno's conclusion that the absence of a first (or last) step in this process negates the existence of motion as well as the conclusions of Descartes and Kant that the impossibility of this potentially infinite process implies the finiteness of time, are not related to this integration. These conclusions follow merely from the potential infinity of the process. Since potential infinity is related to the left hemisphere, it may be implied from these conclusions that

some neural mechanism disturbs the indefinite continuation of the left hemispheric processing one step after another without a last (or first) one, causing us to be convinced that the number of steps is finite. The only possible such mechanism is the right hemisphere.

This last suggestion is in line with experimental findings. According to Fidelman (1988b, Table 1) the understanding of the concept of finite ordinals (as defined by Von Neumann) by students is positively and significantly correlated with the scores on left hemispheric tests, and is positively and insignificantly correlated with the scores on right hemispheric tests. However, the difference between the standardized scores on the right hemispheric tests and the left hemispheric tests (called "the dominance of the right hemisphere") is negatively correlated with the scores of the students on the understanding of the concept of finite ordinal. The absolute value of this negative correlation is larger than the correlation related to the right hemisphere, and smaller than the correlation related to the left one.

Each finite ordinal is defined by Von Neumann as the set of all the previous ordinals in the series. The integration of this set is performed by the right hemisphere, which counts for the positive correlation between the right hemispheric score and the score on understanding the concept of finite ordinals. The treating of this new finite ordinal as an individual element is performed by the left hemispheric mechanism, which counts for the positive correlation between the left hemispheric score and the score on understanding this concept. The negative correlation between the dominance of the right hemisphere and the score on the understanding of the finite ordinal concept may indicate that this understanding involves a conflict between the two hemispheric mechanisms. The right hemisphere tries to integrate all the previously defined Von Neumann's ordinals into a new finite ordinal, thus to terminate the process, while the left hemisphere further proceeds this process. So, the right hemisphere disturbs the indefinite process of creating more and more finite ordinals by the left hemisphere. That is, the right hemisphere participates in the process of producing finite ordinals in two stages. At the first stage it integrates each new ordinal as the set of all the previous ones. At the second stage it objects to the construction of newer ordinals, thus causing a neurological and cognitive conflict between the hemispheric mechanisms. The accumulation of these objections along the potentially infinite process of creating all the finite ordinals may cause neurological inhibition of the left hemisphere by the right, which implies a cognitive conviction that there is no potentially infinite series of ordinals, or equivalently, that the period of the existence of the universe, and therefore of time itself, is finite. The two roles of the right hemispheric mechanism in this process, the first of supporting the process and the second of inhibiting it, may explain why the total correlation between the right hemispheric score and the score on understanding finite ordinals is small.

The inhibition of the left hemispheric mechanism by the right one may explain the emergence of the following observations: in the case of Zeno's paradoxes this inhibition negates the existence of continuous motion, while in the case of Descartes' and Kant's arguments it negates the potential infinity of temporal processes. This inhibition concerns the accumulated inhibitions related to the series of finite ordinals; therefore it occurs before the integration of the potentially infinite process into an actually infinite set,[1] thus this potentially infinite process and the integration are prevented, leaving one with a finite process.[2]

Is Sensory Input a Reliable Basis for Physics?

Sensory input is the basis of empirical science. However, there are limitations on the reliability of the senses because data arrive at our consciousness after being processed by our neural system (Fidelman, 2005b). These limitations are based on the empirical work of Treisman and Schmidt (1982), who investigated the cognitive psychology of vision. They found that visual perception includes two stages. The first stage in pre-attentive. Here the features of the observed item are processed without our awareness of them, and without being localized. The second stage is attentive. In this stage the object is integrated from its features and the integrated discrete object is attended and localized. Fidelman (2005b) suggested that the process of the object's integration from its features is, in fact, the transfer of the processing of the observed phenomenon from the right hemisphere, which processes features, to the left one which integrates these features into an object and perceives this object.

During this process there is a phenomenon of interchanging of features that migrate between objects, prior to (or during) the integration of the features. This phenomenon is known as illusory conjunction. Nevertheless, we do not

[1]More empirical evidence on the relation of the integration of actual infinity to the inhibition of the left hemisphere by the right one is referred to and discussed by Fidelman (1992). The empirical evidence related to the inhibition of the right hemispheric mechanism by the left one, which counts for Cantor's diagonal processes and to foundational paradoxes, is based on several experiments and is well established. However, the empirical evidence on the inhibition of the left hemispheric mechanism by the right one, related to Zeno's paradoxes against continuous motion, is merely initial. The author had to terminate the experimentation before all the goals were achieved.

[2]The finite duration of the temporal processes according to Zeno, Descartes, and Kant is related to a foundational school in mathematics called ultra-intuitionism. According to this school, very large finite natural numbers do not exist. This approach is influenced by Zeno's paradox of the bald headed man. According to this paradox if one hair falls from the head of a person who is not bald he will not turn into a bald one, and so on; the hairs fall one at a time. By induction, there are no bald men in the world; only a relatively small finite number of hairs can fall from the head. The idea of ultra-intuitionism may seem to be strange; nevertheless, mathematicians consider it seriously, because it has a model (non-standard arithmetic) and therefore it is consistent. It should be noted that the possible existence of a relation between the acceptance of the ultra-intuitionist approach and the right hemispheric mechanism has not been tested experimentally.

observe blue grass and green sky, or flat faces and tables with noses. Treisman and Schmidt explain this by the existence of a "censorship" in our central neural system that allows our consciousness to perceive only familiar objects or objects the existence of which do not contradict our logic. That is, we see what we expect to see and not "things as they are in themselves."

A difference between the microscopic world and the macroscopic world is that microscopic phenomena are not perceived directly by our sensory organs. We perceive readings of instruments and interpret them as indicating the existence of microscopic objects or of waves. These microscopic particles are imagined due to a top–down activation of the cerebral visual areas, rather than by a bottom–up activation by sensory input; "object integration" occurs due to the passage of the whole of the integrated features from the right hemisphere (that imagines features of particles, like electrical charge, and integrates them into a new whole, or a new collection of features, but does not perceive this new whole as a single item), to the left one, that perceives this whole as the imagined integrated particle.

The readings of the instruments are macroscopic phenomena, and thus perceiving them does not contradict our logic, and Treisman's censorship is not applied to them during the perception process. Later, when the readings of the instruments are interpreted as quantum microscopic phenomena, detected migrations of features between microscopic particles remain cognized and uncensored.

Fidelman (2005b) noted that there is an analogy between the collapse of the wave function in quantum mechanics of microscopic objects and the object integration of macroscopic objects. From this analogy it is inferred that the collapse of the wave function is a neural process too. Peruš (2001) arrived at the same conclusion by a mathematical analysis of neural networks. According to Fidelman (2005b), this collapse of the wave function occurs while the process of cognizing an object is transferred from the right hemisphere to the left one, causing the "model" of the phenomenon to change from a wave to a particle. Thus the hemispheric paradigm explains also the duality in physics.

Both macroscopic and microscopic phenomena and the difference between them are explained by the hemispheric paradigm. Moreover, the perceived phenomena do not provide a reliable representation of really "what there is," at least since we perceive processed and censored sensory input and not raw sensory input. This lack of reliability is a philosophical obstacle to the empirical foundation of physics.

Is Mathematics a Reliable Basis for Physical Theories?

What is Mathematics?

According to Pythagoras, concrete natural numbers comprise the physical world, while Plato believed that the physical world comprises ideas, among them,

mathematical ideas. According to Plato the physical phenomena are merely an imperfect representation of the general ideas describing the particular phenomena, which include mathematical ideas. Thus mathematics describes the physical world because the physical world consists of mathematical entities.

Modern science knows the role of the neural system in cognition. Fidelman (1991) suggested that ordinal mathematical concepts are related to the functioning of the left cerebral mechanism, while cardinal mathematical concepts are related to the right; more complicated mathematical concepts are created by collaboration between these mechanisms, according to the model of Ben Dov and Carmon (1976). However, sometimes these two cerebral mechanisms cannot collaborate, and their functions contradict each other. A detailed discussion of this issue was presented in Fidelman (1999). Lack of coordination between the hemispheric mechanisms causes a cognitive and a neural conflict terminated by the inhibition of one hemisphere by the other one. This conflict either causes the negation of a natural assumption that some intuitive mathematical entity exists — and then it is called a diagonal theorem — or it causes a basic contradiction in the mathematical and logical systems — and then it is called a foundational paradox in mathematics.

Is Mathematics Reliable?

An example of a diagonal theorem is Gödel's incompleteness theorem (see Fidelman, 1999). It follows from this theorem that it is impossible to prove the consistency of even a basic mathematical discipline like the arithmetic of natural numbers with the operations of addition and multiplication, and therefore of any mathematical theory that includes natural numbers. Almost all mathematical theories include natural numbers, therefore the only reason for believing that any mathematical theory is consistent is our experience that no contradictions were discovered (meanwhile) in basic mathematical theories, such as arithmetic and calculus. But we cannot prove that such contradictions will not be discovered in the future. However, contradictions were discovered in the past in more complicated mathematical theories (e.g., theory of sets) that caused foundational crises. These crises were solved by adding artificial ad hoc assumptions, which do not guarantee that more crises will not appear in the future.

Moreover, according to Fidelman (1991), mathematics is a creation of the human neural system and not some objective Platonic entity. Therefore, mathematics is subjective and thus is subject to all the errors of the neural system. There is no philosophical reason to believe in the reliability of mathematics — and this reliability, insofar as it exists, is merely empirical.

Is the Application of Mathematics to Physics Reliable?

Penrose (1989) implied from Gödel's incompleteness theorem that no computational or formalizable theory of the physical world that includes the brain (as a physical system) is possible. However, he suggested that a Platonic non-computational and non-formalizable theory of the universe that includes the brain is possible. Fidelman (1999) contradicted this last suggestion of Penrose by showing that arguments based on diagonal processes prove that the program of Penrose is not viable.

The human brain is a part of the physical universe. Therefore we may conclude that no mathematical theory, neither formalizable nor Platonic, that describes a universe including the brain of the physicist, is reliable. Everything that we know about the physical world depends on our neural system and its interpretation of the sensory input.

A Suggested Neuropsychological Basis of Physics

In the previous sections we have described the limitations of both the empirical approach and of the mathematical approach to physics. The reasons for these limitations are the role of the hemispheric mechanisms and the lack of their coordination in the perception of the physical world and in mathematical cognition. Since hemispheric mechanisms play a key role in the creation of our cognition, we may try to apply the dependence of physics on the brain to our favor by applying our knowledge of the brain's functioning via the hemispheric paradigm to know in advance which models of the physical world our neural system can possibly create. By turning directly to the brain we may, perhaps, arrive faster and more easily at physical theories that explain the known data. Later, when we know what theories we may expect, we may corroborate these theories by experimentation, mathematical modeling, and mathematical computations.

The macroscopic phenomenon of illusory conjunction (and its microscopic analogue) has a key role in previous studies of the application of cognitive psychology and neuropsychology to physics. This issue has been discussed by Fidelman (2002, 2004a, 2004b, 2005a, 2005b, 2006a, 2006b, 2009a, 2009b). Most, if not all, of these physical results, including those that were first obtained applying psychology, can be obtained from physical considerations alone, without application of psychological considerations (Fidelman, 2006c). The features of each macroscopic object before the object integration and of each microscopic object before it is detected or measured are probabilistic and may interchange between the objects (due to illusory conjunction). Only after the object's integration and the collapse of the wave function do these features become deterministic. One of the features that may interchange between charged microscopic particles (electrons and protons) is electrical charge. If the charges of the electrons and

of the protons of an atom interchange, the atom may turn into an atom of antimatter. According to Feynman's diagram (1985, Figure 64), a particle of antimatter may be considered to be a particle of matter that "travels backwards in time." Moreover, each material particle in nature has some probability to travel backwards in time or equivalently, to be a particle of antimatter. Therefore the interchanging of the opposite electrical charges between particles may be considered as the inversion of the temporal directions of both particles, or the interchanging of the features' "temporal directions" between them.

It is well known to physicists that when a particle of matter collides with its antiparticle (an identical particle that has an opposite electrical charge) they annihilate each other and emit a quantum of γ ray. Therefore, there is some small probability that each atom of matter will be an atom of antimatter and be annihilated due to its collision with another atom. Molecules of solid bodies are held firmly in their lattices; they do not travel in space and do not collide. All of them move in the same temporal direction, otherwise, the solid body would have been disintegrated since part of its molecules would have been located in their past positions while others remain in their present positions. The probability p that any single molecule moves towards the past or, equivalently (since the inversion of the temporal direction inverts the direction of the electrostatic force and therefore it inverts also the sign of the electrical charge) that it is antimatter, is very small. We denote the number of the molecules of the solid body by n, which is very large. Then, the probability that the entire solid body is moving towards the past is p^n. This number is extremely small, and for all practical purposes it may be regarded as zero. That is, all the molecules of a solid body move from the past towards the future, and they cannot annihilate each other.

Suppose that a gaseous molecule (that has some probability to be a molecule of matter, and the complementary probability to be a molecule of antimatter) collides with a solid body and is materialized as a molecule of antimatter. Then we may expect it to be annihilated, together with one of the (material) molecules of the solid body and emit quantum of γ ray. Let us assume that a γ photon that is thus created is detected. Since we know that all the atoms of the solid body move from the past towards the future, the gaseous molecule is made of antimatter; therefore it came from the future towards the present. However, this molecule has been annihilated in the present, it does not exist it the future, and the assumption that it came from the future causes a logical contradiction. This implies that no emission of γ ray may be due to such a collision.

This consideration does not apply to the collision of two gaseous molecules, each of which has some small probability of moving backwards in time since each of them is an entanglement of matter and antimatter. Since no solid body is involved in this collision, we have not a reference by which to determine the temporal directions of the gaseous molecules, and each gaseous molecule may be considered to be an entanglement of matter and antimatter, and therefore

not to have a definite temporal direction. Therefore, the past and future of gaseous molecules are entangled. Moreover, according to Feynman's diagram, we may consider the event of annihilation also as an event of disintegration of the emitted photon into a molecule of matter and a molecule of antimatter that moves backwards in time. Thus, both annihilated molecules have some probability of existing in the future, in the form of an entangled superposition, and to come from there.

Molecules of gases may collide. The molecules of cold gases are slower. According to Heisenberg's principle of indeterminacy, cold gaseous molecules have a greater probability of colliding with each other, and of being annihilated. This psychologically based prediction of physical phenomenon (the mutual annihilation of gaseous molecules due to the phenomenon of illusory conjunction) can be tested experimentally by detecting unexplained emissions of γ rays by cooled gases (Fidelman, 2002, 2005a).

Fidelman (2006a) suggested explaining the electrostatic force by the migration of the feature "having a quantum of directed momentum" between microscopic particles. This is an alternative right hemispheric explanation to the left hemispheric quantum field theory that explains this force by the migration of theoretically undetectable photons (imagined as particles) that carry the electrostatic force between the two particles. This neuropsychological explanation of electrostatic force may be extended also to other forces. Every force may be explained by a migration of the feature "having quantum of momentum" between particles, which is a right hemispheric theory, or by a dual left hemispheric theory of migration of particles that carry the force between two particles.

Neuropsychological Basis for a New Physical Theory

Fidelman (2008, 2009a) discussed the mode of operation by which the left hemispheric mechanism perceives temporal order, and suggested a model explaining why our consciousness can perceive temporal events through our senses only as propagating from the past towards the future. According to this model the left hemisphere cannot invert the direction of the perceived temporal events. Nevertheless, according to some physicists, like Feynman, time can move in both directions.

Fidelman (2006b, 2006c, 2008) discussed Feynman's theory that antiparticles are particles that move backwards in time, and therefore the direction of their electrostatic force (and, equivalently, the sign of their electrical charge) is inverted when the temporal direction of the charged particle is inverted; that is, "a positron is an electron that travels backwards in time." However, this inversion of the temporal direction does not have any influence on the gravitational force, which depends only on mass, and there is neither negative mass nor negative gravitational force. Therefore the gravitational force is always positive.

This observation causes a cognitive paradox: How can it be possible that inverting the direction of time inverts the direction of the electrostatic force (and the order of event caused by it) but not the direction of the gravitational force (and the order of events caused by it)?

The left hemispheric mechanism cannot perceive time as moving backwards. Therefore Feynman's theory can be cognized only due to the transfer of the temporal cognition from the left hemispheric mechanism to the right one (which has a larger number of neural networks and thus can encode many spatial and temporal directions). The right hemispheric mechanism can perceive multidimensional space; it may represent time too as multidimensional. The solution of the paradox that follows from Feynman's theory may be to consider time as having (at least) two independent axes that are represented geometrically as perpendicular to each other: an electrostatic temporal axis and a gravitational temporal axis. This is true at least regarding microscopic electrically charged particles.

Carroll (2005) and Dubois and Nibart (2006) suggested that there are three dimensions of time. This theory is based on the observation that inverting the sign of a particle's electrical charge and the direction of its spatial and temporal axes do not change Maxwell's equations. This observation enables theoretical physicists to perform transformations that invert the directions of axes or transform them to each other. These transformations are called "charge time parity transformations." Carroll (2005) and Dubois and Nibart (2006) applied this observation for transforming temporal and spatial axes into each other, and they received a theoretical universe having three spatial and three temporal axes. Here we see that our neuropsychological methodology of physics has an advantage over the mathematical methodology. Carroll and Dubois and Nibart did not distinguish between the physical properties of their temporal axes and their relation to different forces, nor did they apply their theory to explain and predict physical phenomena.

Maxwell's equations unified the electric and magnetic fields into the electromagnetic field. These equations use the same time variable for all these forces. Therefore we may extend the electrostatic time into an electromagnetic time. However, the efforts of Einstein and others to find a unified field theory that would unite the electromagnetic force and the gravitational force failed. We may explain this failure by assuming that the electromagnetic and gravitational temporal variables related to macroscopic objects too are distinct, as well as those related to microscopic particles. Nevertheless, string theory unified the gravitational and electromagnetic fields by adding spatial coordinates. This success may be explained by the addition of temporal axes disguised as spatial axes (due to charge time and parity transformations).

The splitting of a temporal axis into two independent and perpendicular axes may solve another cognitive paradox (that is related to hemispheric differences):

there is a contradiction between the spatial–temporal continuum of the two theories of relativity (general relativity and special relativity) that represents a continuous world and the discontinuous world of the quantum mechanical phenomena. Ben Dov and Carmon (1976) suggest that the right hemispheric space is continuous, while the analytic left hemisphere cannot perceive events as a continuum (i.e., that between any two events there is a third event) but discretely, one after another in time like discrete beads on a string.

This argument is valid for both microscopic and macroscopic events. However, we do not encounter in our daily life in the macroscopic (everyday) phenomena discontinuous events like discontinuous motion. This may be due to cerebral censorship similar to the censorship described by Treisman and Schmidt (1982). Since this censorship does not apply to microscopic particles, the time of quantum mechanical microscopic events is discrete, and their time may change in quantum jumps as it varies along a microscopic quantum mechanical temporal axis, independent from the macroscopic temporal axis. Due to "Feynman's paradox" (that is related to microscopic particles) this microscopic temporal axis splits into a gravitational microscopic temporal axis and an electromagnetic microscopic temporal axis. The failure of the physicists to unify the macroscopic gravitational force with the macroscopic electromagnetic force without adding spatial dimensions, which may be disguised temporal dimensions, may be explained by the splitting of the macroscopic temporal axis into two axes, an electromagnetic macroscopic temporal axis and a gravitational macroscopic temporal axis.

Thus we have (at this stage) seven spatial–temporal axes, three of them are spatial (length, breadth, and height) and four are temporal (two electromagnetic: microscopic and macroscopic, and two gravitational: microscopic and macroscopic). All these axes are independent and therefore can be represented geometrically as a seven dimensional space having seven perpendicular axes. This division of the physical world into two distinct subspaces, one having two microscopic temporal axes and the second having two macroscopic temporal axes, prevents the contradiction between the continuous nature of space–time into which the relativistic events occur in the macroscopic subspace and the discrete nature of microscopic space–time in which quantum mechanical events, like tunneling phenomena, occur in the microscopic subspace. The events in one subspace are independent from the events in the other.

Electromagnetic Temporal Motion and Resting Mass

We suggest that the traveling of a charged particle along the microscopic electromagnetic temporal axis is equivalent to its having resting mass. According to Fidelman (2006a), when an electron and a positron approach each other the electrostatic force of attraction between the two particles which is proportional

to the inverse of the square of the distance between the two particles, increases. This causes the accelerations and the velocities of the two particles relative to each other to increase as their distance decreases. According to classical physics the electrostatic force should approach infinity while the distance approaches zero. When the velocities of the two particles arrive at the velocity of light, their resting mass is converted into the energy of the frequency of electromagnetic wave, and empirical observations show that these two particles disappear and two photons receding from each other "back-to-back" emerge. According to Fidelman (2006a) the two particles turned into the two photons (this theory is based on the neuropsychological methodology of physics, and is alternative to the theory of Dirac). The detecting of these two photons may be considered as empirical evidence of the particles' obtaining the velocity of light and turning into photons. According to Einstein's special relativity theory, when a particle approaches the velocity of light its passage of time approaches zero[3] and its relativistic mass approaches infinity.[4]

This last observation explains why a particle, like an electron, cannot obtain the velocity of light. The infinity of the relativistic mass is expected to prevent this. Nevertheless, the force of attraction between an electron and a positron also approaches infinity (according to classical physics) while the distance between these two particles approaches zero. The velocities of the electron and positron are subjected to two opposing factors: infinite mass and infinite force. Instead of predicting the behavior of these two particles in these conditions mathematically, we may observe their behavior empirically (certainly, in physics any theoretical mathematical conclusion should be verified empirically). The above observation shows that the two particles are annihilated and are usually replaced by two photons that recede from each other back-to-back, in

[3]According to Einstein's formula

$$t' = t/\gamma$$

where t is the time of the laboratory and t' is the time of the moving particle. We denote the velocity of the particle by v, and the velocity of light by c. We denote

$$\beta = v/c$$

then we denote

$$\gamma = 1/\sqrt{(1-\beta^2)}$$

We see that the larger is the particle's velocity the slower passes its time. When the particle's velocity v becomes equal to c than γ becomes infinite and the passage of its time is reduced to zero.

[4]Let m_0 be the resting mass of a moving particle (i.e., its mass when it is at rest relative to the observer). Then, using the notations of footnote 3, the mass m of the moving particle is:

$$m = m_0 \cdot \gamma$$

This means that when v approaches c then γ and m approach infinity.

directions that are the continuations of the directions of the original colliding two particles beyond the point of collision. This observation may be interpreted as indicating that the resting mass of each of the two particles has been inverted into the electromagnetic energy of the two photons (or, equivalently, into the frequency energy of the electromagnetic wave) that have resting mass zero. The case when only one photon is emitted is also explained by Fidelman (2006a) as an electron and a positron that have collided not head-to-head, but at some angle, moving together as one photon at the velocity of light, in the direction of the resultant of their two motions.

We observe that the two particles that obtained the velocity of light due to their collision lose both their resting mass and their temporal motion. Indeed, according to Feynman (1985, see Figure 64) a photon (that has resting mass zero) does not have a definite temporal direction. This can occur only if this particle does not propagate in time and its temporal passage is zero.

On the other hand, at certain conditions a photon that has neither temporal motion nor resting mass larger than zero disintegrates into an electron and a positron, having both resting mass and temporal motion (either in a positive or a negative direction). The disintegrating photon consists of an electron and a positron that had collided previously, turned into one photon, and moved together in space that were separated in the vicinity of an atom due to the dipole of its electrical charges. In this case, the particles' losing of the velocity of light causes them to aquire resting mass and to move in time: the electron in a positive temporal direction and the positron in a negative temporal direction. The electrostatic force that operates between the electron and the positron varies along the electromagnetic temporal axis. These observations may be explained by the suggestion that a satisfactory and sufficient condition for a particle to move in a microscopic electromagnetic temporal direction, positive or negative, is that the particle's resting mass is larger than zero. Indeed, a physical entity, microscopic or macroscopic, may be defined as an object if it has spatial location, resting mass, and temporal direction.

Since electrically neutral particles usually have resting mass, they should move along the electrostatic temporal axis. We suggest that each neutral particle comprises positively and negatively charged particles, so that the total electrical charge of this particle is zero. For example, an atom is electrically neutral. Thus, neutral particles too move in (electrostatic) time. The electrically positive and electrically negative parts of a neutral particle move together in space due to the presence of electrostatic and gravitational forces of attraction between them and perhaps of other forces of attraction. Thus our psychological physical theory enables us to predict that any electrically neutral particle that has resting mass (like a neutron) comprises smaller electrically charged particles.

Genesis of Time and Space

The currently accepted theory of the beginning of time is the theory of the "big bang," namely, that all the matter and energy of the cosmos emerged from a primordial explosion that started the expansion of space and of all the matter and radiation included in it from one point of singularity towards all directions. The big bang occurred billions of years ago, therefore it cannot be observed directly. It can only be imagined (like the imagining of a microscopic particle). We cognize it only as an interpretation of reading astronomical instruments that indicate the recession of all the galaxies from each other (the red shift of the light of the far galaxies) and the detection of a constant background radiation, interpreted as the remains of the initial radiation.

The cognition of the phenomenon of the big bang begins, like that of every phenomenon, at the pre-attentive stage, which for a microscopic phenomenon is cognized as a wave, and for the big bang it may be cognized as a huge cosmic wave function that is presented to consciousness by the right hemispheric mechanism. In the beginning, the empirical data of the red shift and of the background radiation induced in the right hemispheric mechanism of cosmologists a primordial cosmic wave function. This wave function was a chaos of the entanglement of the entirety of the features of all the photons and particles that would eventually emerge in the cosmos. Then this wave function collapsed, and a multitude of photons (that constitute the background radiation) and particles (that later were aggregated as galaxies) were integrated from their features in the left hemispheric mechanism of these cosmologists.

The second stage of cognizing the big bang is the attentive stage, in which its cognition is transferred from the right to the left hemisphere. The transfer of the cognition of a wave, or of a wave function from the right to the left hemisphere, and replacing it by one or more particles, represents what is called in physics a "collapse of the wave function." Thus, the replacement of an electromagnetic wave by a photon (due to the duality in physics) may be included in this term.

The features of these particles included electrostatic charges. The electromagnetic fields of the photons and the electrostatic fields of the other particles operated on these charged particles and caused them to travel along the microscopic electromagnetic temporal axis, inducing them to acquire mass. This mass allowed, in turn, the charged particles to apply microscopic gravitational force on other particles, thus causing them to travel along the microscopic gravitational axis.

Macroscopic bodies are aggregates of microscopic bodies. The accumulated influence of the microscopic gravitational force of the particles that constitute a macroscopic body causes macroscopic gravitational force and the appearance of the macroscopic gravitational temporal axis. Each of the newly emerging

axes enables spatial motion in its temporal directions, that is, there is a change of spatial locations during changes along the temporal axes. The accumulated effect of spatial motions of a multitude of charged particles along the microscopic electromagnetic temporal axis induces macroscopic electromagnetic force which caused the existence of the macroscopic electromagnetic temporal axis. We observe that the existence of the microscopic electromagnetic time implies the existence of all the other temporal axes.

The Two Proofs for the Existence of Beginning of Time

There are two explanations why we conceive the universe as existing only a finite period of time. Both explanations may be related to the hemispheric theory. The first is the arguments of Zeno, Descartes, and Kant, which contradict the existence of potential infinity by logic. The second is the cosmological approach which, according to our interpretation, considers the appearance of the world as a collapse of a wave function. We notice that the two approaches to the existence of a beginning of time, Descartes' theological approach of creation and the cosmological approach of a big bang, originate in two different neurological processes. The first approach originates from the inhibition of the left hemisphere by the right one, which terminates a potentially infinite process after a finite number of steps. The second approach, the cosmological approach of the big bang, originates from the left hemisphere's taking over the cognitive process of imagining the cosmos' beginning from the right hemisphere. This means that the unification of Descartes' theological approach with the cosmological approach involves a neuropsychological difficulty, which we will try to reconcile.

The Zenonian approach to the beginning of time does not, and cannot contradict the cosmological approach. Indeed, neither Zeno nor Descartes nor Kant could determine when the cosmos began its existence; only the cosmological approach can achieve this. Moreover, the Zenonian approach necessarily implies the cosmological approach, since according to Descartes' argument some finite time ago matter (which can be transformed into energy and vice versa) suddenly appeared in the universe. We saw that a necessary and sufficient condition for the existence of time is the existence of particles having resting mass. Such particles can emerge only from the collapse of a wave function. Therefore the beginning of time must be due to the collapse of a cosmic wave function, which caused the emergence of all the particles of the cosmos.

The End of Time

Descartes' and Kant's proof, applying Zeno's technique, that time has a beginning, can be extended to prove also that time has an end (as well as to

prove that space cannot be infinite). Thus time cannot be infinite neither towards the past nor towards the future.

We observed that the disintegration of a photon into an electron and a positron (that is equivalent to the collapse of a wave function), which move into two opposite temporal directions, is the beginning of time for these two particles. Similarly, the annihilation of resting masses of a colliding electron and positron and the appearance of a wave instead of them may be analogous to the end of time for these two particles. The end of time that follows from Kant's argument must be accompanied by the annihilation of all the rest of the masses of all the particles in the cosmos, otherwise objects having resting mass that travel in time remain. We saw above that this may happen as a result of a strong acceleration of all these particles until they obtain the velocity of light.

Since most of the matter in the world is composed of electrically neutral particles or atoms, the force that causes the acceleration of all these particles cannot be electrostatic or electromagnetic, and it should be gravitational or some unknown force (or "dark energy"). If this force is gravitation it may be related to what some cosmologists call the "big crunch." According to the theory of the big crunch, gravitation will slow the expansion of the universe and reverse the expansion until all the matter of the cosmos will be concentrated in one huge discontinuity, or singularity, of space, known as a "black hole." When the distance between the singularity and the falling particle approaches zero, the gravitational force approaches infinity. Apparently, the gravitation of all the matter of the cosmos, concentrated at one location, is strong enough to do to the falling particles that are approaching its center of mass what the electrostatic force is doing to the colliding electron and positron, namely, accelerating them to the velocity of light and then turning them into electromagnetic waves or photons. It is well known that strong gravitation prevents particles and photons from escaping a black hole. That is, all the particles and photons that fall into this cosmic black hole should disappear due to annihilation (caused by their obtaining the velocity of light), while their features become entangled and comprise one comprehensive new cosmic wave function. This terminal wave function is similar to the primordial wave function, the collapse of which began the existence of our present cosmos. We have related the collapse of the wave function to the transfer of the cognitive process from the right hemispheric mechanism to the left. Now we relate the appearing of the new cosmic wave function to the transfer of the cognition of the cosmos from the left hemisphere to the right one. Thus the big crunch is, both physically and neuropsychologically, a "mirror image," in which the direction of time and the order of the related events are a reflection of the big bang.

However, unlike the big bang there is no empirical evidence that the big crunch will ever occur. On the contrary, there is empirical evidence that the velocity of the recession of the galaxies from each other increases due to some

dark energy, rather than decreases. If this increase of velocity will continue, the particles comprising all the galaxies will obtain, sometime, the velocity of light and turn into photons, having a resting mass of zero. This will be the end of time.

Indeed, at the beginning of the twentieth century the Dutch astronomer Willem de Sitter interpreted Einstein's general relativity theory as indicating accelerated expansion of the universe and suggested that the far galaxies are presently receding at a speed greater than the velocity of light. Therefore, the cosmos has been split into two parts, and no light can penetrate from one part to the other. At the present we can see only light emitted from these far away galaxies before this rupture, but no new light from them can reach us. The particles of these galaxies that are faster than light should have turned into photons that have a resting mass of zero, and therefore they do not move in time relative to us; thus from our point of view time has been terminated for them. These galaxies are, presently, huge wave functions without resting mass just as the particles approaching the center of the black hole of the big crunch will be.

We do not know which, if any, of the two scenarios of the end of time will occur (both scenarios are related to the transfer of cognizing the cosmos from the left to the right hemisphere). Possibly, the far galaxies will escape outwards faster than light, while each galaxy will collapse into the black hole at its center where each particle will reach the velocity of light, but there is no empirical evidence for any of these theories. Therefore, the only argument we have in favor of the reality of time's termination is the Zenonian argument, which is related to Descartes' argument regarding creation; this argument is due to an inter-hemispheric conflict.

The end of time due to the turning of all the particles into one or more cosmic wave functions means that there is a possibility that after the end of time one or more of these wave functions will collapse, causing the emergence of new cosmoses and a new beginning of time. Thus, apparently, it may be that time does not begin and does not end, but there are cycles of genesis and termination of time. However, Descartes' argument applies to this potentially infinite number of temporal cycles, without a first one and without a last one, as well as to ordinary time, and it implies that there should be a first cycle and, similarly, also a last one. However, Kant's argument showing that time is subjective can be applied to this infinite series of cycles. We may conclude that this series of temporal cycles is subjective as is ordinary time.

Conclusion

We have observed how neuropsychological considerations, based on the hemispheric paradigm, may explain the mode in which we perceive and cognize the physical world. This approach may solve a puzzle that has bothered physicists for a long time: how our knowledge of physical events can possibly cause events

to occur. For example, does our knowing that a particle has been detected cause a wave function to collapse, while without our knowledge it will not collapse? The observation that the collapse, as well as our knowledge, occurs in our neural system and therefore both are subjective, solves this puzzle.

It is implied from Kant's Zenonian argument that time (as well as space) can be neither infinite nor finite, therefore it is contradictory and cannot be a thing in itself but it must be subjective; namely, time exists only in our consciousness. We suggest a modern interpretation to the term "subjective," which is a creation of the neural system. Thus Kant's suggestion that everything that we know about the physical world is subjective, and exists in our consciousness, is in line with our theory.

Finally, all the above scenarios for the end of time are possible creations of the human brain. The contraction of the cosmos into a single singularity according to the theory of the big crunch may be related to the transfer of its conception from the right to the left hemisphere. The rupture of the expanding universe into several parts that recede from each other in space, according to the theory of de Sitter, may be related to the right hemispheric mechanism. Thus it is possible that various cosmologists will adopt different theories and wage intellectual wars with each other regarding which scenario suits the real world, while these scenarios do not occur in outer space, but only in their skulls, and are related to a neural conflict between the cerebral hemispheric mechanisms of each of them.

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