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Mind-Body Problem: Does Complexity Exist Objectively?

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Abstract

Complexity and related phenomena exist as at least as "objective" and primary aspects/elements of the world as matter, space, and time. On the other hand, space, time, and matter become more and more subjective in modern physics. Complexity causes "something new" to emerge at the level of the whole complex system, which is not present at the level of the elements of this system and cannot be fully reduced to the interactions between these elements. This fact concerns both simple systems, such as atoms composed of a nucleus and electrons or (macro)molecules composed of atoms, as well as very complex systems such as living individuals built of (macro)molecules, organelles, cells, and organs, and conscious brains composed of networks of neurons. In other words, the dynamic complexity consisting of a special concrete spatiotemporal organisation of matter/energy is as real as space, time, and matter themselves. Therefore, one can speak about the "objective" existence of such a "subjective" phenomenon as (self-)consciousness. The last phenomenon constitutes an aspect, epiphenomenon, or "by-product" of the functional complexity of the (part of the) neural network in the human brain. (Self-)consciousness is equivalent to a certain kind of such complexity and must emerge as a necessary aspect of an appropriately organised dynamic neural network. Therefore, for instance, zombies cannot exist or are even nonsensical. Each dynamic state of the neural network underling self-consciousness is univocally related to one psychic state, and inversely. It is postulated that the mind-body problem can be explained/resolved by a special kind of complexity, which consists of recurrent self-reference, directing on itself the "cognitive centre" in the neural network in the human brain.

Keywords

Self-Consciousness, Life, System Complexity, Human Brain, Conceptual Network

1. Introduction

The general structure and function of the human brain originated in the process of biological evolution. This

concerns, among others, the manner of integration and organisation of the complex of stimuli reaching, from the surroundings, receptors (sensory organs) into spatial (this concerns especially Euclidean three-dimensional space), temporal (with a clearly expressed arrow of time pointing from past to future), and causal relations. The brain has also predispositions to separate discrete objects from the more or less continuous distribution of excitation of light-sensitive cells in the plane of the retina by photons of various wavelengths of electromagnetic radiation (corresponding to various colours) and different concentrations (corresponding to different lightness). The purpose of appropriate brain functioning was to maximise the fitness of our ancestors, that is, to increase their chances of survival and reproduction. Therefore, the human brain and mind were shaped for the effective hunting of mammoths and avoiding predators, and not to serve the development of science and philosophy. People are not universal cognitive machines. In addition, the biological substance of the brain and the basis of its action (in particular neurons of determined structure and function) have an influence on our fundamental categories in which we perceive the world. Therefore, the picture of the world formed in our neural network, and therefore in our psyche, is on no account a perfect representation of the "objective" "facts"/aspects/properties of this world (things in themselves, *noumena*), if such "facts"/aspects/properties exist at all (in the absolute way) or have any sense (Korzeniewski, 2013b, 2015).

The human brain is also characterised by an ease to formulate the idea (concept) of substance and matter (this statement concerns also the "spiritual substance", that is the soul). On the other hand, it is not directed at an "immediate" and "ocular" perception of complexity and complicated structure, not only spatial, but also dynamic structure, "happening" in time. Complexity and structure are treated as secondary phenomena in relation to matter/substance, space and time, and therefore as more "subjective" than them, situated rather on the side of our mind than on the side of the real external world. However, one could pose a fundamental question of whether this "secondarity" constitutes a "true" feature of the world, or whether it is simply a creation of the brain/mind shaped and functioning in such-and-not-another way; whether space, time, and matter actually exist in a concrete, irrefutable, or just somehow absolute way, while complexity and structure are only faint, not concrete and to some extent accidental properties of matter existing in space and time; or whether this is only the human brain/mind that leads to such categorisation or even valuation; or maybe the "real" situation is reverse and this is the complexity and structure of matter in space and time that are more fundamental and primary aspects of the world than matter, space, and time themselves. In this article, I will present just such a point of view, arguing that such complex phenomena as life and self-consciousness, characterised by a special kind of organisation of elements in space and time, exist in the external physical world in a way that is at least as real and "objective" as space, time, and matter. I will argue that "something new" emerges with complexity and structure even in so simple cases as an atom, built of a nucleus and electron shells, or a simple molecule built of a small number of atoms.

2. Do Matter, Energy, Space, Time, Discrete Individual Objects, and Causal Events Exist in an Objective and Absolute Way?

Physics is the most fundamental science dealing with the broadly understood external material world ("containing" matter, energy, space, and time). However, does physics deal with exploring the immanent essence, "substance" of the external world? Does it investigate what the broadly understood matter "really" is? Let us consider a few examples.

Modern physics treats elementary particles either as points of zero dimensions or strings of zero thickness. However, what is, then, the "substance" of elementary particles? A point-like "something"? "Something" possessing the shape of a string? What would this string be made of? Is perhaps a particle the place of the greatest intensity of some physical field, e.g., an electrical or gravitational field? And in such a case, what is the "substance" of this field? Particles propagate in space as probability waves and the probability of finding a particle in a given point of space is described by the so-called wave function. However, again, what is the essence and substance of such probability wave? And what happens with this substance at the moment of the so-called collapse of the wave function? We do not perceive matter in its immanence, as a Kantian thing in itself (*noumenon*), as naïve realism could suggest, but through the prism of our mind (co-created by our senses as well as by lower- and higher-level integration and association of data coming from them). The properties of matter in particular, and the so-called external world on the physical level in general, are approached by us in the frame of theoretical physics through mathematical constructs. Physics offers only a formal mathematical description of "reality". It does not take care, as it cannot, of what kind of "substance" actually fills these constructs.

When, in an atom, an electron transits from an orbital of a higher energy to an orbital of a lower energy, a quant of electromagnetic radiation (photon) is emitted having energy (wavelength) corresponding to the energetic difference between these orbitals. Are we not dealing here with an "objective" event, an "objective" level of physical reality? Not at all. We are only able to notice a coincidence (somewhat exaggeratedly called a causal relation, see Hume, 1975) between the transition to a lower orbital and emission of a photon, but we do not know where this coincidence comes from. We do not know why just a photon is emitted and not something completely different happens. Somebody could oppose that our ignorance is not so big, that we are dealing here after all with the principle (law) of energy conservation. However, first, we have no idea why in fact energy should be preserved. We conclude this only by induction. Second, we cannot say why the energy is released in such and not another form. In addition, we do not know what an electron, orbital, electromagnetic wave, or energy "actually" are, what their ultimate nature or essence is. We do not know why the intensity of the electrical or gravitational field decreases with the square of distance. And, most importantly, we cannot learn this on principle, because the substance of our psyche, whatever it might be, is different from the substance of this "out there". Our physical theories, deeply anchored in mathematics, are able to describe an astonishingly great number of apparently unrelated to each other phenomena. We do not know, however, why just such-and-not-another mathematics applies, with a better or worse approximation, to different aspects of the physical world. There are numerous branches of mathematics that have little to do (at least according to contemporary knowledge) with the real world. The mathematical description of reality still remains very incomplete and imperfect, and supposedly it will remain like so forever. Apart from this, mathematics is only a certain formal structure and as such does not deal with the essence or substance of the world. Finally, its completeness and consistency is still negated (Barrow, 1992) (I personally do not believe in it, see, e.g., Korzeniewski, 2013b, 2014).

A serious problem is met in the case of the "essence" of such objects as elementary particles, for instance a photon, electron, or one of a few distinguished kinds of quarks. All electrons, for instance, are "identical" (have the same properties, e.g., electrical charge, resting mass, spin, or magnetic moment). Therefore, it seems easy to distinguish the category of objects called "electrons" and to indicate univocally a given particular electron. However, on closer look, there appear serious difficulties. Particular electrons occupy different places in space and, therefore, it must not be said—in agreement with the real state of things—that all properties of particular electrons are the same (there are different space coordinates of their location, different intensities of the electrical and gravitational field in their neighbourhood, different locations of other elementary particles). Electrons can be created or annihilated in various quantum transformations, in which other elementary particles also participate. Moving electrons have greater mass than resting electrons (therefore mass depends on velocity in relation to other objects). We do not understand, in fact, what the electron is. According to (standard) quantum mechanics, electrons behave both as waves and as point particles. In some contemporary conceptions (string theory, Greene, 2010), the electron is not a point particle, but a circular string vibrating in different ways. However, as mentioned above, we have no idea (and, on principle we cannot know this, because of the nature of the "content" of our mind that is completely different from the nature of the "content" of the physical Universe), what the "substance" of such a point or string might be. Before it is detected, an electron is neither a point nor a string, but it propagates in space as a wave. Therefore, the above statement about its determined location was already an abuse of meaning. An electron bound in an atom is not located in any particular place, but forms a kind of a "cloud" (that can have different shapes) called an orbital, whose local "density" determines the probability of finding a given electron in different points in space. As a wave, a free electron can pass through two slits simultaneously, and its location and velocity are generally determined only with a certain approximation. The more exactly we know the location, the less information we have about the velocity (impetus), and *vice versa* (the Heisenberg indeterminacy principle). But this happens only until the moment an electron is detected by some apparatus, when the so-called collapse of the wave function takes place and the electron becomes localised in a particular place in space. In fact, nobody has an idea what such a collapse consists in. The so-called conception of decoherence says that the stronger an electron interacts with the surroundings, the more it loses its wave properties, the less it is "blurred" in space (Penrose, 1990; Tegmark & Wheeler, 2003). Therefore, the properties of elementary particles do not belong to the particles themselves, because they are also derivatives of other "objects". Two elementary particles—for instance two photons or a pair electron-positron that originate together as a result of certain quantum processes—constitute to some extent one whole (so-called quantum entanglement) (Tegmark & Wheeler, 2003). This means that the properties of these particles are strictly connected, although none of these particles taken separately has these properties determined. If such particles go away from each

other in opposite directions and find themselves at a distance of, say, one million light years, then determining such properties (by measurement) for one particle determines automatically and instantly the properties of the other particle (for instance, if a certain property adopts the value of 1 for one particle, then it adopts the value of −1 for the other particle). In other words, particles (their properties) are correlated—this constitutes a manifestation of the so-called nonlocality of quantum mechanics (it has been confirmed experimentally) (Penrose, 1990; Tegmark & Wheeler, 2003). It is worth emphasising that in the Universe's past, in particular just after the Big Bang, when the Universe was extremely small, pairs of elementary particles repeatedly underwent creation and annihilation, and therefore we have reasons to suppose that all of them are mutually correlated with each other. And, in the face of this, the properties of elementary particles are determined by the context of all other elementary particles. Therefore, something like a single, isolated elementary particle simply does not and cannot exist! We cannot analyse some (subjectively and arbitrarily) isolated part of the Universe in separation—the Universe must be considered as a whole! In fact, the problem is even more enigmatic. This is so because, at least according to some theories, the positive energy related to matter counterbalances exactly the negative energy resulting from the distance in space between bodies endowed with mass in the gravitational field, and therefore the total energy of the Universe is exactly zero (Hawking, 1988). Therefore, it can be said that, after the Big Bang there originated only information (related to negentropy) about mutual separation of matter and space[1]. In other words, nonentity was split into the positive energy of matter and negative energy of space. In the face of this, the existence of matter—and therefore also of elementary particles—would be dependent on the existence of space. And ultimately, the existence of anything in the Universe would be dependent on the existence of anything else. The Universe is relational and the only thing that "really" exists is the information about the relative arrangement in space/time of different objects contained in it.

Therefore, for instance the electron is not a fully autonomous object (or a category of objects) that can be considered and analysed separately from other objects, and to which univocal properties and independent existence can be attributed. For this reason, we are dealing here, at least to some extent, with a not fully determined notion/name, which makes the pretence of absolute, independent, and objective existence of electrons of determined, univocal, and understandable properties. When we have the name "electron", we have a subjective impression that we know what the electron actually is, we attribute to it some form of objective, absolute existence (Korzeniewski, 2013b, 2014). But this impression is only an illusion. Matter, including electrons, is to a large extent a subjective category/phenomenon of our mind.

One of the leading examples of the subjectivity of modern physics is the famous and commonly known Schrödinger's cat paradox.

Generally, we can see only some aspects of the things in themselves. Let us come back to an electron. Depending on the method of observation, an electron appears to us as a particle or a wave. The question of whether the electron "really" belongs to one of these categories is meaningless. In addition, the claim of an electron's "wave-particle duality" is only a simplification created by our mind. The particle or wave nature of the electron is most probably a manifestation of a much richer deeper structure, irreducible directly to a particle or a wave, being something more than their "sum". Different aspects of an electron (and of physical reality in general) are simply subjective categories within our mind.

Up to this point, I have been discussing mostly "objects" in the real world, but the same reasoning also applies to processes vs. "events". It was written before (Korzeniewski, 2013b): "There is no 'discrete' causality in the real world, where a 'sharply-defined' reason causes a 'sharply-defined' result (an 'event'), for instance, in the case of snooker balls, when one ball strikes another and sets it in motion. Instead, there is only continuity of processes, for instance, when some atoms of one ball, kept together by the electrical force, interact with some atoms of another ball, and the latter moves as a whole, also because the electrical force that keeps its atoms together. In fact, one should talk not about atoms, but about electron shells of atoms (orbitals) that are 'blurred' in space, as discussed above. In this way, macroscopic 'facts' are extracted by the human mind (according to discrete, quantised nature of language and the mechanism of sensory data integration by the brain) from microscopic continuous processes".

Science differs from, for instance, philosophy or religion in its methodology, which ensures congruence between its subjective linguistic and conceptual structures, and the "objective" structures and the world. However, this congruence is far from perfect and this distinguishes real science from its idealisations. The error of absolutisation consists here of a naïve belief in a real and "sharp" existence of such objects described by science as

[1]Somebody religious could say that "the word became flesh".

the orbital of an electron, gravitational force, or biological species, being general concepts. The same also applies to the planet Earth and a given, concrete individual of alga or canary (or a man) (see Korzeniewski, 2013b, 2014). In this case, the qualification "real" does not mean an existence totally outside of our psyche, which I by no means intend to negate, but an existence in the forms, categories, or even values produced by the human mind. At the same time, I do not share the original opinion of Immanuel Kant that "things in themselves" (*noumena*) are completely non-cognisable (Kant, 1999). If our categories had nothing in common with the real structures of the world, we would not survive as a biological species, and we would not achieve such spectacular success in the natural sciences.

In the commonsensical understanding (that constitutes the starting point for philosophy), matter is something tangible, possessing a location in space, weight, consistency, colour, and dimensions—it is something that can be transformed in different ways, but not annihilated. All these attributes disappear in theoretical physics. The essence of such a well-known, intuitively understandable, and clear concept becomes here very mysterious and exotic. Matter can vanish, transform itself into energy, in accordance with Einstein's famous formula: $E = mc^2$. We are not able to decide whether, e.g., the wave function is a material object or a construct of our mind, and therefore we cannot draw a sharp border between physical reality and the content of human consciousness! According to the special theory of relativity, distance in space and time depends on the relative velocity. The general theory of relativity proclaims that matter is not only the substance filling space, but it also shapes this space, causing its curving proportional to mass. Due to some hypotheses, there may be no sense in speaking about time before the beginning of the Universe. In other words, time has no "beginning"—it "emerges" in some region of space-time (close to what we call the Big Bang) from one of four spatial dimensions (Hawking, 1988; Davies, 1996). We are no longer able to recognise in this entanglement of the absurd and curiosities our familiar concepts of matter, space, and time formed on the basis of experience of reality through our senses, concepts that have formed the subject of philosophy for two thousand years. Such an apparently clear and obvious concept as the concept of matter, after closer examination, has escaped our grasp, leaving an empty name. In physics, the concept of matter, which seemed previously so "objective", now practically does not exist. It has been dismantled into the concepts of field intensity, equivalence with energy, particle-wave duality, and probability function. Einstein's general theory of relativity is a great example of the phenomenon of relativism and relational nature of meanings in a conceptual system—the concepts of space, time, matter, gravity, speed, and energy are so formulated there, that they explicitly have meanings only in relation to other concepts. If we removed one element, the whole structure would collapse. Thus, for example, the removal of matter would change the structure of space-time dramatically. For instance, according to Mach's principle, the matter filling the Universe constitutes the reference point for every movement, especially circumvolution (Greene, 2005).

The perceiving of the flow of time is also to a large extent a subjective, psychic phenomenon. One can consider a four-dimensional space-time as a "frozen", unchangeable block in which no "real" flow of time takes place. The arrow of time, pointing from the past to the future, present in thermodynamics and related to entropy increase, is also in a sense subjective (Coveney & Highfield, 1991). It is absent in dynamics, including Newton's dynamics, Maxwell's electromagnetism, relativity theory, and quantum dynamics (the only exception is the collapse of wave function mentioned above, the nature of which still remains very mysterious and unclear). However, we undoubtedly experience the psychological, which means subjective, arrow of time, where the past precedes the present moment that in turn precedes the future. Therefore, time (its unidirectional flow) is at least partially a subjective phenomenon.

Generally speaking, such phenomena of the world as matter, space, and time (and also such "aspects" of the world as individual objects, causality and discrete events, see Korzeniewski, 2013b, 2015), appearing in our minds as appropriate concepts corresponding to them, are as much representations of the "objective" "things in themselves" (*noumena*) as a result of the "subjective" mechanisms of sensory data processing and integration, active autonomous processes of association of different "neural objects" and memory formation, and spatiotemporal patterns of effectors (especially muscles) activation. Therefore, matter, space, and time are by no means fully (or at least predominantly) "objectively" existing aspects, "facts" of the world.

3. Properties of Simple and Complicated Systems Equivalent to Their Complexity

In the previous section it was argued that such apparently objective phenomena/aspects of the external reality as matter (including, e.g., elementary particles), space, time, discrete individual objects and events, and causality are not so objective at all. On the contrary, in the development of modern science they seem to be still more and

more subjective products of our mind, concepts related rather to psychical phenomena, than to "real" physical *noumena* (things in themselves, Kant, 1999). Below, it will be discussed that different apparently subjective properties of physical systems equivalent to (the kind of) their complexity are no more, no less objective/subjective than the elements of these systems on different levels of the hierarchy of complexity.

The properties of protons and neutrons (e.g., mass, electrical charge, exerting and being a subject of the strong nuclear force) are equivalent to the "complexity" of the arrangement of the system composed of three quarks they are built of (two quarks u and one quark d in the case of the proton, and one quark u and two quarks d in the case of the neutron). While, e.g., the charge of a proton and neutron can be easily calculated as the sum of the charges of quarks they are composed of (a proton is built of two quarks u of charge +2/3 and one quark d of charge −1/3, and therefore has charge +1, while a neutron, as it can be easily calculated, has charge 0), other properties of a proton and neutron (e.g., asymptotic freedom of quarks) are a very indirect (and still poorly understood) derivative of complex interactions between quarks and several sorts of gluons (carriers of a strong nuclear force).

The properties of the atomic nucleus (e.g., stability/instability and radioactivity) are equivalent to the complexity of the system of protons and neutrons entering into its composition. Certainly, the nucleus does not behave as a simple "sum" of protons and neutrons. For instance, protons repulse each other because of the positive charge they are endowed with, while the whole nucleus remains intact because of the strong nuclear force acting between protons and neutrons.

The properties of atoms of particular elements (valence, electronegativity, absorption and emission spectra, other physicochemical properties) are equivalent to the complexity of the nucleus and, especially, to the complexity of the system of electron orbitals of different shapes (orbitals s, p, d, f), especially those forming the valence shell, and their occupancy by electrons. The properties of elements as substances (e.g., colour, state at room temperature, specific gravity) results in turn from the properties of particular atoms, but also from the complex interactions between them. For instance, it is not trivial that sulphur as a substance is yellow and fragile, because single sulphur atoms are not "yellow" and "fragile".

The properties of, e.g., water molecules (physicochemical properties, e.g., polarity) are equivalent to the complexity of the spatial arrangement of one oxygen atom and two hydrogen atoms (bound through molecular orbitals). The properties of water as a substance (liquidity in room temperature, temperature of ice melting and steam condensation, transparency, dielectric constant, specific gravity) are equivalent to spatial dynamic organisation and of the huge amount of water molecules and mutual interactions between them. The same concerns the properties (physicochemical properties, specific gravity, colour) of other, usually more complex, molecules and substances. The same can be said about three-dimensional networks of ions/atoms/molecules forming crystals.

Similarly, the properties of more complex molecules, especially polymeric (composed of many units-monomers) molecules of organic compounds (spatial structure, physicochemical properties), are equivalent to the appropriate complexity of the sets of (appropriately arranged and bound to each other) atoms and monomers they are composed of (in the case of organic molecules: mainly atoms of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), sulphur (S), and ions of metals). This concerns first of all the molecules constituting the basis of life, responsible for specificity of particular organisms: nucleic acids (DNA, RNA) (constituting strands of four nucleotides) and proteins (being chains of twenty amino-acids). The fact that DNA appears in the form of a stiff double helix, RNA is much more flexible and can adopt different three-dimensional structures, while proteins have multiply structures and functions, results from the properties of the complexes of their monomers. The (frequently very complicated) structure, function, and properties of a given protein are equivalent to the complexity of the amino-acid chain with concrete, such-and-not-another sequence of amino acids (the three-dimensional structure and function is determined by such a sequence).

An analogical situation takes place in the case of higher-order cellular structures, for instance cytoskeleton, ribosomes, and chromosomes composed of proteins and/or nucleic acids. Their structure and function, their "macroscopic appearance", are equivalent to the complexity of the sets of their elements.

The characteristic properties, structure, and function of the whole living cell are equivalent to the appropriate complexity of the set of its components: protein-lipid membranes, cytosol, cytoskeleton, organelles (e.g., mitochondria), ribosomes, chromosomes, and so on.

Living organisms as whole systems, both uni- and multi-cellular, possess (are equipped with) a certain special sort of dynamic complexity characterised by an internal purposefulness directed at the realisation of definite

functions and tasks. Such a superior task of the whole organism is survival and, first of all, reproduction. The unit, system, which is directed towards its own survival and reproduction, and is self-sufficient in the realisation of this goal, can be defined as a living individual (Korzeniewski, 2001, 2005, 2013a). On the other hand, particular parts/elements of a living individual, such as cells and organs, carry out subordinate functions leading to execution of this superior task. The kind of complexity characteristic for living individuals is discussed in more detail in the next section.

Finally, the subjective psyche and (self-)consciousness is equivalent to a special kind of functional complexity of the neural network in the human brain (Korzeniewski, 2010, 2013a, 2013b, 2015), as discussed in one of the following sections.

Generally, there is no reason to treat various properties of "real" systems, equivalent to the (kind of the) complexity of the set of elements on different levels of hierarchy of the dynamic arrangement of matter in space and time, as less "objective", "basic", or primary than matter, space, and time themselves, especially that the latter phenomena become increasingly more subjective in modern physics.

Of course, not all sets of many (frequently a huge number of) elements form complex systems. For instance, some 10^{25} or so homogeneously distributed gas molecules in a sealed container are not arranged in any kind of macroscopic ensemble. Nevertheless, even in this case we can define some macroscopic properties of the system, such as temperature or pressure, but they are not a derivative of any complex internal structure. In addition, e.g., spiral galaxies, although they look spectacular in photographs made by space telescopes and are composed of a central concentration and spiral arms, are simply rotating sets of stars that are kept together by gravitational attraction counter-balancing the centrifugal force coming from the rotation of the whole system. There are essentially no interactions between particular stars, and therefore a galaxy does not form a complex system.

Nevertheless, the systems we are most interested in in the present article, namely biological and psychical (conscious) systems, are characterised by a high degree and, especially, a special kind of complexity that is characteristic (unique) for them and determines their essence. Certainly, different elements of living individuals and conscious brains enter into numerous and diverse interactions. I will argue that this (kind of) complexity is at least as real as the matter they are built of and the space and time they exist (function) in.

4. The Complexity of Biological Individuals

Thermodynamics in a very general way defines such terms as amount of information, structure and degree of complexity, as well as entropy of a system inversely proportional to them. Statistical thermodynamics operates with the concept of a macroscopic state that contains a determined (usually very huge) number of microscopic states (Penrose, 1990; Conley & Highfield, 1995). However, the very procedure of distinguishing, defining different macroscopic states is to a large extent subjective. What is more important, the thermodynamic information, structure, and complexity is something very different from the kind of information, structure, and complexity we are interested in relation to living individuals.

First, the maximal amount of thermodynamic information, "structure" and "complexity", and consequently the lowest entropy, was present just after the beginning of the Universe (Big Bang), when a homogeneous distribution of matter and energy in space in the gravitational field took place. The objects in the Universe that are characterised by the highest entropy are black holes. Additionally, the greater a black hole, the higher is its entropy. The size of black holes can increase as a result of absorbing matter from the surroundings or of a fusion of two black holes. Therefore, the final stage of the evolution of our expanding Universe will be matter condensed (concentrated) in (consumed by) still greater and greater black holes. Life does not originate and exist in systems characterised by the lowest entropy and highest thermodynamic information, structure, and complexity. On the contrary, living systems at different levels of hierarchy are dynamic systems functioning at intermediate entropy, amount of thermodynamic information, structure, and complexity. They can exist only in systems in which great thermodynamic gradients are present and are driven by an increase of entropy (dissipation of energy) (Schrödinger, 1992). Biological systems are the so-called (hierarchically organised systems of) dissipative structures (Prigogine, 1980; Prigogine & Stengers, 1984), examples of which in the inanimate world are convective currents and whirls in water during a turbulent flow. The thermodynamic information, "structure" and complexity of the system: nutritional substances + oxygen is greater than the thermodynamic information, structure, and complexity of the human body that uses nutrients and oxygen to develop and sustain itself during life. However, they are not the kind of information, structure, and complexity we are most interested in the case of biological

systems. Therefore, while physics (thermodynamics) can formulate conditions necessary for life to origin and persist, it cannot reach the very heart of the essence of life, to explain its most immanent properties.

Second, thermodynamic information, structure, and complexity are something different than biological ones. Of course, a sufficiently large amount of thermodynamic information is necessary for life to exist, but this kind of information does not determine the specificity of biological systems. While thermodynamic information is "indifferent" in relation to living beings, biological information is "purposeful", "intentional" (in the operational sense), and directed at the realisation of a particular task. The superior task of living individuals is survival and reproduction.

The purposefulness of living systems is expressed on different levels of the hierarchy of complexity: biochemical and genetic networks, organelles, cells, tissues, organs, systems of organs, and entire living individuals. All parts/elements of a living individual support other parts/elements and are necessary for their existence/functioning. For instance, neural cells/brain support muscle cells/muscles, liver cells/liver, kidney cells/kidney, and so on. On the other hand, liver cells/liver support neural cells/brain, muscle cells/muscles… Ultimately, all cells/organs support all other cells/organs. Their functions mean by mutual relations to each other, by connotation. This reciprocal relation is sometimes called the "causal closure". All cells/organs also support reproductive cells/organs. Ultimately, all cells/organs support the entire living individual, its survival in good health, and maximum possible reproduction. The information related to all these purposeful structures/functions is "tendentious", "valuable", biological information, completely different from (although based on) indifferent, not related to any purposefulness thermodynamic information.

The biologically relevant, purposeful information has many aspects, e.g., structural, functional, genetic, or energetic aspects. It was also formulated in cybernetic terms (Korzeniewski, 2001, 2005, 2011, 2013a). Cybernetics, dealing with regulation and information transfer in complex systems, is the only formal science that is able to explain the difference between living individuals and inanimate objects/systems. Additionally, the cybernetic definition of a living individual (that constitutes a subject of evolution, unit of selection) distinguishes this individual from its parts/elements, e.g., cells and organs, that can be also considered "alive", but are not self-dependent (self-sufficient) in the realisation of the superior goal—survival and reproduction (Korzeniewski, 2005, 2013a). The cybernetic living individual is a functionally closed system, while particular cells and organs are not. The following cybernetic definition of the living individual has been proposed: **the living individual is a network of subordinate, mutually supporting each other negative feedbacks (or, in broader terms, regulatory mechanisms and signal transduction pathways) ultimately directed on (being at the service of) the superior positive feedback (reproduction, expansion of the identity of the individual)** (Korzeniewski, 2001, 2005, 2013a). It was also postulated that this is the most minimalistic definition of life (living individual) that manages to remain valid. Although it is very abstract, all other fundamental properties of living systems can be derived from this simple formula, when it is confronted with the real world (Korzeniewski, 2005).

The negative feedback maintains the value of a given parameter near the assigned ("optimal") value, counteracting any deviations of the parameter value from the assigned value caused by external disturbances. Negative feedbacks are present both in inanimate devices constructed by men and in living organisms, where they are very frequent. In the former case it can be a thermostat that maintains an approximately constant temperature in a refrigerator or corrective engines that maintain an appropriate course of a rocket and compensate any deviation of the actual course from the pre-set trajectory. From the cybernetic point of view, living individuals are in fact "built of" a network of a great number of hierarchically-organised and mutually interconnected (supporting each other) negative feedbacks. A few examples of such negative feedbacks are as follows. On the biochemical level, the present concentration of a given amino acid regulates the rate of its synthesis: a high concentration of the amino acid inhibits its synthesis, while a low concentration unblocks it (Umbarger, 1978). As a result, the amino-acid concentration remains approximately constant despite variations in the rate of its supply from the guts and consumption by, e.g., protein synthesis. On the genetic level, appropriate regulation of gene expression maintains the concentration of proteins encoded by these genes on a desired level (Jacob & Monod, 1961; Alberts et al., 2007). On the physiological level, two hormones keep a possibly constant concentration of glucose in the blood: insulin decreases this concentration, while glucagon increases it (Cryer, 1991). Appropriate negative feedbacks strictly control the rate and strength of muscle contractions and thus enable smooth and coordinated locomotion, manipulation with different objects by a hand, and speech generation (Kawato, 1999). On the level of the whole individual, the complex neural system steers the behaviour of an animal in response to the

variability of the (signals from the) environment (surroundings) in space and time, after confronting them with memory records. These actions enable maintenance on an appropriate level of many various parameters: the amount of nutritional substances, water, minerals, temperature, the lack of parasites and diseases, the lack of body damages by predators or inanimate objects, and so on. On the level of the "super-individual" of an ant colony, the humidity inside the anthill is strictly regulated by sterile ant workers (Wilson, 1971). During embryonic development, a hierarchically-organised cascade of morphogenetic processes, including morphogen gradients and cascades of the regulation of gene expression during cell differentiation (DeLeon & Davidson, 2007; Gilbert, 2010), determines the size and shape of a specific structure and the type of cells it is built of at a given moment of embryogenesis (Gilbert, 2010; Wolpert et al., 2002). For many more examples and detailed discussion see (Korzeniewski, 2001, 2005, 2013a).

Positive feedback operates in the opposite manner to negative feedback: it leads to the faster increase in a given parameter value, the greater this value already is. An example of this feedback in the inanimate world is the nuclear chain reaction, where the number of free neutrons increases exponentially in time, while in the living world—the mentioned reproduction of living individuals.

Generally, biological systems (in particular: living individuals) are characterised by a high degree and very special kind of complexity. This complexity, unlike the "indifferent" purely physical complexity, is purposeful, tendentious, and directed on the realisation of a particular task—survival and reproduction. This complexity manifests itself, among others, as a network of appropriately-organised negative feedbacks (and as other purposeful aspects of structure and function). This network constitutes, in a sense, a created by biological evolution, functionally purposeful **representation of (some aspects of) the external world (and the interior of the individual)** (Korzeniewski, 2001, 2005, 2013a). The feedbacks in the network (as well as various aspects of structure and function in general) "**mean**", have any functional sense, by relation to other negative feedbacks (aspects of structure/function), that is **by connotation**. Ultimately, all negative feedbacks mean in relation to all other negative feedbacks, constituting the cybernetic aspect of the living individual. More generally, all purposeful aspects of structure and function are **intentional** (in the operational sense). Namely, they support and are related to all other purposeful aspects of structure and function of such an individual. Ultimately, all of them are directed towards survival and reproduction. In other words, a living individual (its identity) is **directed on itself** (relation of **recurrent self-application**), at its own self-copying.

In my opinion, this special kind of complexity of biological systems, responsible for their uniqueness, exists in an at least as objective, primary, and "real" way as the atoms and (macro)molecules they are composed of and the space and time they function in. Therefore, this (kind of) complexity is as real as the purely "physical" matter.

5. The Complexity of Psychical Individuals

The conscious self can be identified with the psychical individual, as opposed to the biological individual. A theory concerning the material background of (self-)consciousness, based on a special kind of matter complexity, has been proposed previously (Korzeniewski, 2010, 2013a, 2015). The neural network in the brain that underlies the subjective psyche and (self-)consciousness is built of neural cells, neurons. They transfer neural impulses through specialised appendages: axons and dendrites, connected by synapses. A function of a given neuron is partly determined by its internal properties, that is the way in which it transforms signals received on inputs (synapses situated on dendrites) into the signal on the output (the axon and synapses located on it and connecting it with dendrites of other neurons). However, the role of a given neuron in the neural network is mostly determined by its functional context, that is by this with which other neurons it is connected with and in what (functional) way. The role of these other neurons is in turn determined by their own internal properties and external connections, and ultimately the function of all neurons is "defined" by all other neurons forming the neural network in the brain. Therefore, particular neurons and their complexes "mean" by **connotation**, by functional relation to each other (and to the entire set of receptors and effectors, especially muscles; Korzeniewski, 2010, 1013a).

Signals coming from appropriately stimulated receptors (eyes, ears, skin receptors of touch, receptors of "internal feeling"—proprioceptors) are processed and integrated into sensory data of different modalities (visual, auditory, olfactory, tactile data). For instance, in the case of the sense of sight, varying in time stimulation of particular photosensitive cells (cones and rods) by photons (quanta of electromagnetic of appropriate wave-

length), analogous to pixels in a video camera, is integrated by the neural network in the brain into spots, and subsequently into lines/contours, colours and movement, simple and complex shapes, individual objects, discrete causal events, and finally into, e.g., faces of particular persons. The so-called integrative structures within the brain are responsible for this (Korzeniewski, 2010). In humans, these structures are partly inborn and partly acquired during an individual's life.

Repeatable coincidence in time of the stimulation of various sets of integrative structures is consolidated into neural structures corresponding to particular, individual "objects", "facts" of the external world, which I call **primary associative structures** (Korzeniewski, 2010). **Secondary associative structures**, corresponding to general categories, rules, principles, and ideas are formed, in a sense on a higher level, by a repeatable stimulation of various sets of primary associative structures that is characterised by temporal and/or situational coincidence. The autonomous activity of the brain, that is processes of thinking, participates in this process. It extracts similar patterns, neural "objects", and analogies from primary associative structures. Particular primary and secondary associative structures mean, like single neurons, by connotation, in relation to each other.

Associative structures may correspond to certain behavioural patterns (e.g., a choice of a plant or insect to eat, a decision to follow this-and-not another hunting strategy) or to a certain category of objects and regularities that are present in the external world (e.g., recognition of particular objects, knowledge of the laws and dependencies, anticipation of future events). They also combine stimuli and sensory images from different senses (sight, hearing, smell, etc.) into one integral whole.

For instance, as a result of accumulation of experience, there emerges the associative structure corresponding to a lion (or a more vague structure corresponding to a big terrestrial predator), the directive demanding "do not eat plants with big round leaves with red dots and a certain smell, or else you will get poisoned", or an action plan stating that "it is easiest to hunt down an antelope in rainy season by lurking in bushes covered with thick leafage". At the neural level, this process proceeds through the establishment and enhancement of neural connections (by lowering the sensitivity thresholds of synapses) between "routes" or "circuits" within the network of neurons in the brain that represent relevant features/aspects of the world extracted from sets of receptor-generated signals and that are responsible for the generation of certain behaviours (or suppression of certain behaviours).

It is of equal importance for the brain to remove and/or weaken (by raising the sensitivity threshold of synapses) inappropriate connections that lead to incorrect identification of objects or to inadequate behaviour (from the point of view of fitness). An associative structure constitutes a certain "circuit", a neural "object" in the brain, where nerve impulses can flow easily and are readily transmitted, which allows the entire functional structure to be activated by a relatively weak stimulation. For instance, the spotting of small fragments of a cat running through high grass easily activates the entire associative structure/concept of a "cat".

The process of formation/strengthening and removal/weakening of associative structures is supervised by the motivation system: inborn instincts/drives (e.g., self-preservation instinct, sexual instinct, the instinct of appetite satiation, instinct of avoiding injuries, illnesses and poisoning, cognitive instinct), plus the reward/punishment system (Korzeniewski, 2010, 2013a, 2015). The system creates and strengthens these associative structures that are correlated (in temporal or circumstantial terms) with satisfaction of instinctual needs and therefore stimulate the reward/punishment "centre" in a positive way, while weakening and eliminating the structures that are associated with lack of satisfaction of instinctual needs and stimulate the mentioned centre in a negative way. If a given behaviour leads to satisfying some instinctive need/drive, for instance to satiation of hunger, the associative structure at the base of such behaviour will become strengthened/consolidated. The reward/punishment system will send appropriate signals to appropriate neural circuits/associative structures. The same will happen if some blurred outline recognised as a leopard actually turns out to be a leopard. On the other hand, poisoning after eating an insect with a characteristic colour pattern, failure in a hunt after selecting a given hunting strategy for a recognised type of prey, or incorrect prey identification will result in weakening the associative structures at the base of these behaviours.

On the psychical level, primary and secondary associative structures correspond to primary and secondary concepts (Korzeniewski, 2010, 2015).

The discussed mechanisms make the network of associative structures purposeful and i**ntentional** (in the operational sense), and not directionless and accidental. This network becomes a **representation of** (some aspects of) **the external world** that, primarily, serves the superior purpose of a living individual: survival and reproduction (maximisation of its fitness).

I postulated that self-consciousness emerges when the "cognitive centre" in the brain becomes recurrently directed onto itself, receives and processes signals both from receptors and sensory cortex and from itself (Korzeniewski, 2010, 2013a, 2014, 2015). This centre is a complex "neural circuit", which compares data received from receptors (integrated by the sensory cortex) with memory records, co-ordinates various functions of the central nervous system, and makes decisions concerning the stimulation of effectors. The centre confronts the signals from the environment with the already-existing neural network containing memory records and world-view shaped within this network. At the same time, it uses appropriately integrated sensory data to develop and extend the network (among others, to form new memory records). At the level of the neural network, its operation consists of the activation, creation, and modification of associative structures of the lower and higher order. A fundamental role in its functioning is played by the autonomous activity of the brain cortex, i.e., thought processes. The cognitive centre is most probably dispersed across large areas of the prefrontal and frontal cortex. In animals devoid of the subjective psyche and self-consciousness, it receives and processes signals only from receptors and the sensory cortex. In a self-conscious brain, the cognitive centre receives signals also from itself. Therefore, according to the presented theory, the essence of a psychic individual is based on the relation of self-reference. In other words, the "cognitive" centre in the self-conscious human brain is **directed on itself**, forms a representation (model) of itself within itself. This is just the special kind of complexity that is, in my opinion, equivalent to the subjective psyche and (self-)consciousness. I believe that it is the relation of self-orientation or self-application that constitutes the new quality, the specific mode of functional (operational) architecture of the neural network, which has led to the emergence of self-consciousness.

In other words, the emergence of (self)consciousness within the neural system underlying the discussed cognitive centre would consist of orienting a part of the inputs of the system on the system itself, i.e., in self-recognition of the processes occurring in the above-mentioned centre. The processes would also "process" themselves, as they formerly processed the data obtained from receptors. Apart from the image of the external world, the centre also establishes within itself an image of itself. In my theory, psychic consciousness is closely linked to self-consciousness, as the former is conditioned by the latter.

The inseparable relationship between (self-)consciousness and the kind of dynamic complexity of the neuronal network that underlies it has far-reaching implications, e.g., for the problem of zombies. Zombies, that is people possessing the material structure, including the brain structure, identical with the material structure of "normal" people, but devoid of the subjective psyche and (self-)consciousness, are quite frequently used in different philosophical discussions concerning the mind-body problem (Hauser, 2006). However, in my opinion, zombies on principle cannot exist and are even nonsensical. This is because (self-)consciousness is equivalent to (a derivative of) the special kind of dynamic complexity in the human brain. Once such complexity originates, it must "generate" psyche, mind, and (self-)consciousness. Or, more strictly, it is equivalent to (in a sense—identical with) these phenomena. Generally, every dynamic state of the part of the neural network underlying (self-)consciousness is univocally related to one subjective psychic state, and inversely. In other words, a such-and-not-another spatiotemporal pattern of neural network activity is inevitably equivalent to (in a sense—identical with) a given concrete conscious phenomenon, and a given concrete conscious phenomenon must be "generated" by a given unique pattern of signal transduction in the brain.

Generally, from the formal point of view, the living individual and psychical (self-conscious) individual seems to have to some extent analogous kinds of complexities. Namely, it has been proposed previously (Korzeniewski, 2013a) that: "The (biological or psychical) individual is constituted by a network of elements (negative feedbacks/regulatory mechanisms or neurons/concepts, respectively) that possesses the following common properties: 1) it is intentional (in the operational sense); 2) its elements signify (have sense) by connotation (through relations to each other); 3) it contains an instrumental representation of (some aspects of) the world; and 4) it is self-referential, i.e., recurrently directed on itself (its own reproduction or representation, respectively). Thus, life and self-consciousness have deep, formal, structural similarities when viewed abstractly." The kind of complexity that characterises both the biological and psychical individual is responsible for the "special", "distinguished" status of the phenomenon of life and (self-)consciousness. The idea of continuous, from generation to generation, reproduction (self-copying) of (the identity of) a living individual and of the recurrent, incessant projection of the cognitive centre onto itself is aimed at explaining the dramatic qualitative dissimilarity to the physical and biological world, the specific and exceptional character of the "living" sphere of biological phenomena, and the subjective sphere of psychic phenomena, respectively. This allows the kind of complexity that is equivalent to the essence of life as well as of (self)consciousness and *ego* to be defined and characterised.

Of course, the crucial for us difference between life and self-consciousness is that we see the former "from outside", while the latter "from inside".

6. Spatiotemporal Complexity of Matter vs. the Conceptual Network

In my opinion, matter, space, time, and discrete objects and events, on the one hand, and complexity, structure, and the dynamic arrangement of system elements and information, on the other hand, are all concepts within the conceptual network that constitutes the "substance" of the human subjective psyche, (self-)consciousness (Korzeniewski, 2010, 2014, 2015). The neural network in the human brain constitutes the material background, "carrier" of the conceptual network. The elements of both networks, neurons and concepts, mean by connotation, relation to other elements. Primary and secondary associative structures correspond to and are the "carrier" of primary and secondary concepts, respectively. A given concept means what it means, because it is (functionally) connected (related) to such-and-not-other concepts—it is "defined" by them. The meaning of these concepts is determined by (relation to) yet other concepts, and ultimately all concepts are defined by all other concepts within the conceptual network. Generally, concepts, similarly as neurons and their networks underlying concepts, mean by connotation. The "semantic intensity", individuality, determination of a given concept is a derivative of the number of its relations with other concepts. The best-separated, determined concepts possess their names in the sphere of language (being ultimately also a part of the conceptual network). Little determined, vague, and unclear concepts do not have counter-parts in the sphere of language—linguistic names corresponding to them. While language is a discrete phenomenon composed of absolutely separated linguistic names and sentences, the conceptual network has a continuous character. Concepts in the conceptual network resemble hills in a landscape—they pass smoothly one into another. There are no sharp borders between them (Korzeniewski, 2010, 2014). Language is a very useful tool allowing efficient manipulation of concepts within the conceptual network. It also enables communication between different psyches, translation (although imperfect) of one conceptual network into another. However, at the same time, it shapes and distorts to a large extent the picture of the world created within this network (Korzeniewski, 2013b).

It was postulated that the conceptual network constitutes the substance of the subjective psyche, (self-)consciousness (Korzeniewski, 2010, 2013a, 2014). On the level of the conceptual network, all concepts, both most concrete and most general, are "equal", of the same sort, equivalent to each other. The hierarchy of concepts is flattened to zero. All concepts are equally "real", "objective", and "primary". For this reason, the concepts of matter, space, and time are no more "fundamental" or "elementary" than the concepts of dynamic complexity, structure, purposeful information, or intentionality. Therefore, there is no reason to argue that (a given sort of) dynamic complexity is a derivative of matter, space, and time. As discussed above, modern physics says that the existence of matter and space can be associated with the complexity and information related to stratification of nonentity into the positive energy of matter and the negative energy of distancing of material bodies in space "filled with" a gravitational field. This kind of complexity is the essence of the subjective sphere of mental phenomena (e.g., concepts in the conceptual network are in fact an effect of "splitting" of semantic nonentity along "significative axes"; Korzeniewski, 2014, 2015). Therefore, our intuitive impression that matter, space, and time are more objective than dynamic complexity is totally subjective.

7. The Essence of (Self-)Consciousness

I believe that the problem of the essence of (self-)consciousness is on principle irresolvable due to cognitive limitations of man. We are not able to "grasp" and comprehend the essence, "substance" of the self-conscious mind, just as we cannot perceive "with our own eyes" a four-dimensional cube, curved space, or phase space. We can only quote purely instrumental procedures leading to their construction, and next investigate their properties with the aid of mathematical analysis. In fact, I regard trials of solvation of the problem of the essence of consciousness (and, in fact, of anything else) as pure philosophical speculations devoid of any sense. Generally speaking, we do not know what the essence of matter, energy, space, and time is. We have no idea why the world is as it is, and we will never know this. We will never learn what the world "really" is. We can formulate *post factum* laws of physics, on the basis of experiments and observations, but we cannot learn why they adopt such-and-not-another form. We can only predict what conditions must be fulfilled for a given event or phenomenon to occur—physics gives descriptions and prescriptions, uses mathematical formalism for (approximate)

representation of the world, and objects and processes present in it, but does not investigate the essence of the world, the nature of the "substance" that constitutes its "filler".

8. Conclusions: Mind-Body Problem vs. Neural System Complexity

The conclusion of the above considerations is that the subjective psyche and self-consciousness is equivalent to a certain determined kind of complexity of the neural network. This kind of complexity consists of the relation of recurrent self-reference, self-orientation on itself of the "cognitive centre" in the human brain. The existence of this complexity is at least equally objective as the existence of the matter the neural network underlying self-consciousness is composed of, the space this network is arranged within, and the time this network is functioning in. The human brain, shaped by biological evolution, has great difficulties with direct "seeing" and comprehending the phenomenon of complexity. Therefore, it possesses a tendency to attribute to it a less objective, fundamental, and independent character than to matter, space, or time.

The mind-body (spirit-matter) problem—i.e., the problem of the relation between the subjective psyche and (self-)consciousness and the objective external reality—is undoubtedly one of the most important philosophical problems in the history of humankind. However, as most (if not all) philosophical problems, it can be (at least in my opinion) reduced to neurophysiology, to the mechanisms of integration and processing of sensory data coming from receptors, formation/enhancement and elimination/weakening of associative structures (underlying the processes of memory formation and usage, thinking, and decision-making), resulting finally in possible stimulation of effectors (chiefly muscles). Another, much simpler philosophical problem "generated" by neurophysiology is the status of general beings (universals) (sets, categories, classes). The philosophical approach know as realism claims that they exist "objectively", while the opposite opinion known as nominalism says that they are only conventional terms useful in classification of individual beings. However, according to neurophysiology (at least in my understanding), general and abstract beings simply correspond to secondary (higher level) associative structures within the neural network (and thus to secondary concepts within the conceptual network) (Korzeniewski, 2010, 2014, 2015).

Therefore, answering the question posed in the title of the present article we can say: yes, complexity exists objectively (at least as objectively as matter, space, and time), and the mind-body problem (spirit-matter problem) can be reduced to the special kind of dynamic complexity of matter arrangement in space and time. This special kind of complexity consists of the relation of self-application, directing on itself, and is isomorphic with the famous paradoxes: the liar's paradox, Russell's antinomy of classes, and Gödel's proof (Korzeniewski, 2010).

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