Vitalism and the Cognizing Universe: Time for a Comeback?

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Abstract

It is generally believed that vitalism has been disproven and must be relegated as a pseudo-intellectual relic of the history of science. Moreover, idealistic conceptions that posit cognition as a basic primitive of realty are also widely believed to be incompatible with current scientific evidence. We highlight how the conjectures about the nature of life and mind, have been dismissed too early and need a more convincing review. The arguments against vitalism lay on shaky foundations. We will also argue that current scientific evidence not only allows, but even suggests, that vitalism could go hand in hand with some form of idealism if we posit a life-principle and a mind-principle as two distinct aspects of consciousness preeminent over matter. However, we won't argue in favor of vitalism, rather that it was and remains an open question that, contrary to widespread claims, has not been ruled out by modern science.

Keywords: vitalism, basal cognition, universal consciousness, evolution, metaphysics, philosophy of mind, mind-body problem, cosmopsychism, panpsychism, philosophical idealism

Contents

Introduction

The history of vitalism and the meaning attached to it is long and variegated. We won't go into the details here (for a review see (Wolfe & Normandin, 2013).) It may only be said that conventionally one distinguishes between 'physical vitalism' (or 'scientific vitalism' or 'process vitalism'), and 'metaphysical vitalism' (or 'essential vitalism').

Metaphysical vitalism thought of a special vital essence, the 'vis essentialis' that supposedly infuses and animates all organisms and demarcates living form non-living matter and a 'vis mediatrix' responsible for the action and coordination of bodily parts. Already Plato and Aristotle posited that there is a force immanent to the organisms and which supposedly makes life fundamentally distinct from non-life. Aristotle hypothesized that the soul (the psyche) organizes the form and structure of an organism and its purposeful activity. Later, Galen (129-210) assumed that spirit (pneuma) was the essential principle of life, an idea that continued throughout the Middle Ages. It became a matter of scientific debate when French biologist Jean-Baptiste Lamarck (1744-1829), better known for his foundational contributions to evolutionary biology, postulated the existence of an ordering 'life-power' augmented by an inner 'adaptive force' with which each organism adapts to the environment. These powers stand behind evolution and are responsible for the increasing complexity of organisms. Part of this was also the notion of soft-inheritance (contrasted to the hard-inheritance based on genetic inheritance independent from environmental factors)–that is, the notion that physical traits can be passed on to the offspring even if the parent organism acquired it only in its lifetime by means of its interaction with the environment. The doctrine of essential life humors found also its way through in medical practices. Therapeutic bloodletting (bleeding the patients) was thought as an effective method to release the excess vital fluid considered the culprit of every ailment and disease. Needless to say that this practice presumably killed more people than it helped and was finally dismissed as pseudo-science at the end of the 19th century.

Physical vitalism, instead, looked for life's mechanism, action and system dynamics with empiric and anatomical observations. For example, it pursued the question how a swarm of bees can coordinate their behavior as a unique 'super-organism'. Physical vitalism accepts physico-chemical determinism but differs from the physicalist's viewpoint inasmuch that it does not embrace a reductionist approach that cuts down everything to physical concepts. Its most notable supporter was French physiologist Claude Bernard (1813-1878) who argued for the uniqueness of life, the impossibility to see the organism as the sum of its parts and which, instead, has to be seen an integrated and harmonious whole, and posited homeostasis as the foundational principle of life. It might, therefore, not come as a surprise that Bernard contributed most to the eclipse of metaphysical vitalism.

But the distinction between physical vitalism and the classic physical and mechanistic concept of life is, after all, only very subtle, if any. Modern non-linear complex system dynamics theories in developmental biology ('organicism') which describe emergent properties of a system that cannot be explained in terms of the properties of its constituents (Gilbert & Sarkar, 2000) could be labeled as a modern form of process-vitalism as well. Deep down, however, it is only a matter of semantics: these theoretical frameworks remain tightly anchored in the orbit of physicalism. For this reason, from now on, we will focus on metaphysical vitalism, and call it just vitalism, if not meant otherwise.

Also French chemist Louis Pasteur (1822–1895) proposed that a 'vital action' makes life inherently different and special compared to non-living matter. Pasteur was inspired by Francesco Redi's famous experiment that disproved spontaneous generation (maggots are not generated by rotten meat, rather come from fly eggs) taking this as evidence that life must always originate from life. The thesis was that there cannot be, not even in principle, spontaneous generation of life from non-living matter.

In 1907, French philosopher Henri Bergson (Bergson, 1907) attempted to revitalize vitalism. According to Bergson, the principles of Darwinian evolution are not sufficient to explain evolution's creativity. In life, there must be something more, an 'élan vital' – a 'vital impetus' or 'vital force' – responsible for the innovative complexity of nature and the morphogenesis of living beings. Also, our urges, desires, feelings and emotions that impel us to action come from the same internal creative impulse. It is this self-impelled force within plants, animals and humans that determines its effort, to overcome the inertia of matter. Bergson's hypothesis was an attempt to find a compromise between a mechanical and finalistic conception but was met with indifference or ridicule. British biologist Julian

Huxley sarcastically rejected Bergson’s idea, comparing the élan vital hypothesis to that of an ‘élan locomotif’ (‘locomotive driving force’) to explain the operation of a railway engine.

A more advanced neo-vitalist version came from the German embryologist Hans Driesch (1867–1941), who theorized the presence of an ‘entelechy’, an intensive, rather than extensive substance or entity, determining the organic processes and reminiscent of Aristotle's entelechy – some sort of vital and self-organizing principle, which aims to realize a specific design or purpose. Driesch articulated his theory with what he took to be a mindlike essence in all living things, observing the development of sea urchin embryos into whole organisms.

Thus, despite all, vitalistic concepts arose regularly throughout history. In the modern scientific context any form of vitalism is rejected as an ancient and obsolete superstition and recalls in the subconscious collective spooks, ghosts and spirits. Whereas, in the contemporary culture vitalism survives in traditional healing practices, energy therapies, chiropractic, biofield therapies such as Reiki or in other healing methods based on the qi or prana 'subtle energies', as postulated in Eastern cultures. It is normally assumed that the former arouses as the final winner from the history of science, while the latter are forms of popular pseudo-science where a therapeutic effect, if any, can be explained away by placebo effects.

1. The meaning of life

The dismissal of vitalism is based mainly on three pillars.

First of all, a non-material vitalism is metaphysical in the sense that it postulates the existence of a non-physical ‘life-fluid’ that, per definition, isn’t detectable by physical means and, thereby, positions itself, beyond the boundary of conventional scientific investigation. We defer further discussion of this point to section 6 where we will question if that is really the case.

Secondly, vitalism is ignored by the adoption of an acritical use of principles of parsimony – Occam’s razor – according to which we should refrain from multiplying entities and from positing any hypothesis that is not in line with the dominating paradigm. “Vitalism is an unnecessary hypothesis”, is the instinctive mantra. But science was not able to furnish any proof for the sufficiency of the opposite hypothesis either, namely that life can be reduced to life-less mechanistic processes. Occam’s razor has never been a criterion that makes a theory ‘scientific’. While it can be a methodological guidance for simplifying our conceptual frameworks and diminishing an experimental workload, it has much too often also fulfilled that unfortunate function to reinforce an ideological background, rather than a genuine search for truth.

Thirdly, the exclusion of any vitalistic hypothesis is based on hope. The hope that sooner or later everything will be recast in the current paradigm. It is a hope upheld by the belief that it is only a matter of time, funds and research that everything will be explained inside a naturalistic framework. However, facts have shown that the findings of the last century made vitalism even more difficult to expunge. As we are going to show, the organization and function of life revealed itself to be much more complex than expected and the goal of eliminating any vitalistic and teleological temptation appears today even further away than it was a century ago. The explanatory gaps did not shrink, but rather, they grew larger.

In fact, the question is: has vitalism been disproven? The answer depends from what we mean by vitalism. If we mean by that a vis essentialis that accounts for a humoral balance that must be reestablished by bloodletting therapies, or a vis mediatrix that allegedly flows through the nerves contracting our muscles, the answer is clearly positive. But did science answer to the primary and original questions that led to the conjecture of vital forces in the first place?

Even though there is no universally accepted definition, vitalism can be described in its original intent as an answer to following intuitions.

1) Our inability to explain and define what is life, is due to the fact that in living matter there is something fundamentally different from non-living matter.
2) The inner psychological force of an organism driven by intentionality, desire, instinct of survival, striving, will, aim, purpose, and motivations can’t be reduced to mechanistic principles only.
3) The origin of life is not explicable by the laws of physics and chemistry only.
4) The growth and development of biological form can’t be explained by mechanistic principles only.

5) The creative inventiveness of nature generating all the morphological diversity of species cannot be captured by mechanistic principles only.

We will argue that, contrary to common belief, these fundamental statements have not been disproven, they were simply ignored. Nobody was able to answer Plato's and Aristotle's doubts. Developmental biology is still far from explaining the growth and development of an organism. The Darwinian paradigm alone, especially in its 'modern synthesis' version, turned out to be insufficient to explain the variety and morphological development of species. Vitalism needs not to deny Darwinian evolution based on principles of natural selection, genetic drifts, random mutations, environmental factors, adaptation, etc., rather finds it unconvincing that these are self-sufficient and fully explanatory principles. That these metaphysical claims are unnecessary or were disproven was and remains an a priori assumption that is not substantiated by scientific facts. Science does not know how to explain, in a naturalistic framework, the origin of our instincts, will-force, cognition, let alone consciousness, and is nowhere near able to generate life in a test tube.

2. The mind in life

Moreover, as a further aspect we would like to highlight, is also the fact that life stands in its full splendor in front of us with its cognitive dimension as well. Every form of life, including the most primitive unicellular organism, as we are going to see, displays different degrees of cognitive behavior. According to scientific materialism, mentality in its low or high-level cognitive function, must be explained in the limits of a reductionist and physicalist formulation. All those cognitive tasks we characterize as 'mental', are considered epiphenomena and emergent properties, resulting from biophysical interactions of networked elementary units, such as molecules or neurons.

There is, however, now sufficient empiric evidence that suggests how, at least forms of 'basal cognition', do not necessitate neither a brain nor a nervous system. Meanwhile, the mind-body problem of the philosophy of mind remains, more than ever, an actual debate that fails to find a commonly accepted resolution. Despite the enormous advances of neuroscience and consciousness studies within the last decades, mind and consciousness remain one of the most elusive aspects of reality and there is no sign that they will be naturalized anywhere soon. Ultimately, vitalism cannot be abstracted from David Chalmers' 'hard problem of consciousness', yet another impenetrable fortress with which physicalism is dealing, that also asks for a satisfying closure of the explanatory gap between neural correlates and the subjective experiential and mental dimension of phenomenal consciousness.

This led to the recent revival of metaphysical ontologies, such as panpsychism or idealistic and panentheistic conceptions of universal mind. Most notably, panpsychism has been reconsidered in its different forms by modern leading philosophers in the field, like Thomas Nagel (Nagel, 1979) Galen Strawson (Strawson, 2006), David Chalmers (Chalmers, 2015), Philip Goff (Goff, 2017) and on the other side of the spectrum, theories of cosmic consciousness, such as I. Shani's cosmopsychism (Shani, 2015) or B. Kastrup's analytic idealism (Kastrup, 2018), just to mention the most notorious. These do not posit matter, but rather consciousness or mind, as fundamental.

Motivated by this state of affairs, we briefly review some of the most recent findings, especially in cell and developmental biology, that highlight how conventional arguments that reject vitalism and cognition as a fundamental aspect of the phenomenal universe, are misplaced or, at least, are much too simplistic. Seeing life and mind as an appearance arising out of a mechanistic clash of material forces and particles or, on the contrary, as fundamental properties already inherent in matter itself, is not just a philosophical musing, but something that influences a mindset behind the very practical aspects of science and will determine its progress or stagnation.

3. A Short Reply to J. Huxley

Firstly, let us consider J. Huxley's counterargument, since it is one of the most cited objections, making it clear how misunderstood the real vitalistic claim is. J. Huxley misses Bergson's point; the question is not so much what stands behind the physical motion force of organisms, which obviously can be explained away by mere physical and chemical reactions. A simple electrical impulse can lead to a muscle contraction also in a dead body, as the Italian physicists Alessandro Volta, well known as the inventor of the electric battery, first observed by applying an electric current to the amputated legs of a frog. The question is where does the creative impulse of novelty and the urge to reach an ever-increasing complexity and variety of forms we observe in the evolution of life come from? Why does every living being act as if having agency, aim and purpose? And what is and where does that will to survive, will to action, will to reproduce, will to grow, will to expand, will to know come from, making living matter so distinctive from non-living matter? Genetics, biophysics, chemistry and biology explain the mechanical workings and energetic dynamics of the material substrate but do not tell us anything about the volitional force, the coming into existence of a conscious subject, the will that determines it and moves it. Vitalism does not pretend to explain the nature of the mechanical principles and forces that set an organism in motion, rather it posits the existence of an intentional principle, a 'desire-force' and a 'will-force' inherent to the dynamics of life. Whereas there is no sign that the élan locomotif, namely the steam's heat transformed into mechanical energy, imparts to the railway engine any creative force or will to generate new engines or leading it to a novel behavior with agency and purpose other than spinning endlessly the flywheel.

These misinterpretations come from the improper use and interpretations of words as 'vital force' or 'vital energy'. Here one means, first and foremost, a psychological property or eventually also a subtle trans-physical 'substance' inherent in living matter, but not, or not necessarily, something to relate to the strict notion of force and energy in physics. If these vital 'forces' or 'energies' have to be intended literally as physical properties, namely that of the ability to impel a change of motion in time or to be able to produce physical work on material objects, is a secondary matter. The question remains what makes living matter different from non-living matter and why does a neural network produce life instincts and a psychological 'will-force'? On the other side, the misnomers of 'force' and 'energy', in the context of vitalism, are also not so misplaced either, since, as everyone knows all too well, an 'emotion', which etymology comes from the Latin 'emovere', meaning to stir or agitate, can be a quite powerful 'force' of life that can set us pretty much in motion.

We argue for the necessity to distinguish between consciousness, mind and emotions in the sense that life and mind are two sides of the same coin, namely consciousness. Yet, they should not be conflated one with each other. Will, emotions, passions and feelings possess a different quality than thoughts or physical perceptions. They can be felt in the physical as an effect of their intensity, but they feel like an internal phenomenon and apart from an external physical stimulus. They can be triggered by a mental state but have a different quality than a pure mental content. The appearance in our mind of an abstract concept, such as the square root of two, does not at all feel like an emotion, such as love, hate, fear or joy. Everything from our subjective first-person phenomenal experience indicates that emotions and feelings have a quite different ontology than that of thoughts and intuitions that can hardly be conflated one to the other. Reducing all emotions to mental states is no more and no less tenable than reducing all mental states to emotions. These are all details and subtleties that, nonetheless, make a whole difference, all of which Huxley ignored, commenting only on the external material dynamics of a living being, but making little or no connection with its whole internal dimension.

4. The Gene God and Morphogenesis

Until recently, biology answered to Bergson's hypothesis of a 'creative morphogenesis' and to Driesch's 'vital self-organizing principle', more elegantly than Huxley, with a naturalistic counter-hypothesis: there is no life force since every morphological organization and its development can be explained in terms of genetic expressions, and their mutation in time is determined by their interaction with the environment.

This is another ad hoc hypothesis without substantial proof that, however, could, in principle, save the appearances. The widely accepted premise was that all our morphological traits are encoded in the DNA molecule, like a 'book of life'. This sounded appealing and was held for a long time as the most plausible, if not even an established fact. But the data that emerged from the Human Genome Project shortly after the turn of the millennium, showed unequivocally how this idea, which was dominant throughout the 20th century, was flawed. One of the main findings of the genome mapping and analysis of the past two decades was that the complexity of an organism does not scale with the number of genes in the genome. The DNA's functionality is much more limited than once imagined. It mostly serves as a template for amino acids that make up polypeptide chains transcribed into RNA, then translated into proteins (in fact, only a small fraction of the genome is actually translated, the rest is 'non-coding DNA'–

the infamous and inappropriately named 'junk DNA'.) It is not a genotype that determines the phenotype – that is, the DNA does not specify how proteins will have to be assembled together to create the anatomical architecture of a fully developed organism. There is no evidence that the genome functions like a 'computer program' that codes for the morphology of the body (for some reviews see (Cutlip, 2020), (Cohen et al., 2016), (Pistoi, 2020).)

Whereas the instructions to form an organism arise from an extremely complex network of interactions and relations between components, such as a myriad of cell signaling factors, enzymes, other proteins, amino acids, vitamins, minerals, etc. Genes are a passive database to build proteins, but they neither design nor control the shape, form and structure of a living being. We now know that the DNA codes for the ingredients not for the recipe. And, as the study of epigenetics has shown further, the heritable phenotype changes are possible without altering the DNA sequence, involving instead the gene activity and expression which, among other things, may result from how the organism responds to the external or environmental factors. There are complicated non-genetic factors that cause the organism's genes to behave differently.

Of course, physical traits like the hair, skin and eye color, facial features and so on, depend on the inherited gene pool. But none of these traits originate from a single gene, rather they are the result of several streams of chemical synthesis, controlled by regulatory networks which dynamics controls the genetic transcription. Even this results, in most cases in a statistical outcome, not a certain and predetermined fact. More evolved functions depend upon even vaster regulatory networks and thousands of genes. Genes are only one of the players in an incredibly complex process inside the whole cell. Moreover, it is now known that genetically identical individuals do not grow identically, even if subjected to the same environment, while large genetic variations can lead to the same phenotypical trait via multiple alternative pathways (Wagner & Wright, 2007). Cells and organisms can also alter their own DNA, rewriting their genome throughout life (Shapiro, 2013). By reading the DNA one cannot determine the shape and size of an organ of a creature, it even does not tell us if there is a particular organ at all because it is not the DNA molecule that determines it.

As genomic studies have shown, we humans share 98.9% of our DNA with chimpanzees (Suntsova & Buzdin, 2020). The remaining 1.1% codes for olfactory receptors, some having to do with the size of the pelvic arch which allows us to walk up right, for fur and differences in the immune system. But nothing in the genome determines a cognitive difference, except for genes coding for a higher number of rounds of cell division during fetal brain development, leading to thrice as many neurons in the human brain than in that of a chimp brain. Which makes it clear that the difference in cognitive abilities between humans and chimps is not a matter of genetic difference. The genes encode only for a quantity which, much later, enables a quality, but there is nothing in the genome that determines that quality. The latter must somehow be acquired with experience by our human neocortex which embodies the main cerebral differences between our brain and that of other animals. There is nothing in our genes that codes for these skills, other than saying "multiply chimp neurons by three".[1]

Therefore, the popularly conceived notion of genes as a blueprint, encoded in the DNA as a program determining the organism's structure, its development, its variations up to every physical trait and even our psychological inclinations, does not exist. We are not nearly as determined by our genes as once thought. The hope that by manipulating one or few genes we could control our intelligence or social behavior turned out a vain chimera.

This 'gene-god' myth has been kept alive for more than a century and still survives, because it resonates with the linear naturalistic and reductionist narrative which likes to think units, particles, molecules and single genes doing everything. We did not doubt this until compelling evidence to the contrary emerged.

Another aspect that turned out too hard to be expunged is the (apparent or real) teleological dimension of life. An intriguing example of this comes from morphogenesis – that is, how from a single fertilized cell, a highly complex self-assembling pattern emerges, developing the organism appropriate to its species. What are the mechanisms and the underlying bio-physical and chemical phenomena that

[1] But does size really matter? Not really, since the brain of an elephant has three times the number of neurons humans have, and the weight and volume of a sperm whale brain measures six times as much. One might consider that a neuroanatomical uniqueness of humans is the number of neurons in the cerebral cortex: about 16.3 billion neurons vs. the 9 billion within a gorilla and the 6 billion within chimpanzees. But this makes the reasoning circular.

preside to complex pattern formations, such as the self-assembly of structures as an eye, a limb and the entire 'bodyplan' during embryogenesis? How do organs regenerate after injury? How can large numbers of cells coordinate their individual activity to assemble themselves into organs and achieve geometric and functional goals that are defined at a macroscopic scale of the whole, but cannot be found anywhere at the cellular level, not even in the genetic code? Nowadays, we know that there are also correction mechanisms with adaptive decision-making capabilities within living tissues able to correct and adjust embryonic development despite forceful induced defects (Vandenberg et al., 2012). An inherent 'goal anatomy' that does not stop at the formation of an adult organism, well known from the salamander's amazing ability to regenerate an amputated limb.

Contrary to popular belief, biology is far from having any coherent theory capable of explaining how all this works. What we know is that it looks like this self-monitoring and repair of complex multi-tissue organ systems and its pattern formation involves a bioelectric code that drives and changes the cell's transmembrane electric potentials. Large scale anatomical pattern formation is regulated by very complicated networks of bioelectric signalling among cells which determine differentiations and regulation of the embryonic development, regeneration of injured tissue and even avoid tumour formation (Tseng & Levin, 2013).

In developmental biology, old and despised concepts, such as the *'morphogenetic field',* have been revived – that is, the idea that a group of cells leading to the development of specific morphological structures must be envisaged in a space and time long-range dynamical information processing whole, rather than mere units executing an internal genetic program.[2]

Of course, conventional science hopes to be able to reduce that to ordinary electro-chemistry by speaking of hugely complex 'long-range signals', 'planar polarity of proteins on cell surfaces', 'standing waves of gene expression', 'trans-membrane voltage potential and tensile forces' and *"chemical morphogen gradients carrying information about both the existing and the future pattern of the organism"* (Levin, 2012). Interestingly, however, some admit that the pervading 'teleophobia' that avoided intentional idioms which attribute goal-directedness to a system, turned out to be all-or-nothing thinking that has prevented discovery, which *"has gone too far, putting biologists into a straitjacket that prevents them from exploring the most promising hypotheses"* (Levin & D.C., 2020).

This concession is interesting. The dream is no longer to reduce everything to genes, but to an electrochemical machinery. But this also remains a hope. Previously, all hope was laid into the existence of a 'gene-god', that sooner or later would have abolished any vitalist temptation. Now developmental biology resorts to bioelectric molecular signal functions at long range. The fact is that morphogenesis, despite a century of studies, is still shrouded in mystery. Of course, this is no proof of any kind of 'élan vital' either, but nothing has eliminated the original vitalist claim that morphogenesis needs a vital force and/or a goal-directed process and that there must be a 'mind-like essence', an indwelling 'idea-plan' of assembly, without which life cannot develop.

5. What is Life?

The other claim of the vitalist is that there is a fundamental difference between living and non-living matter. However, also the attempt to abolish the distinction between non-living matter and living matter, with the intention to reduce the latter to the former, remains more elusive than ever.

Famous is Erwin Schrödinger's question "What is Life?" (Schrödinger, 1943), which precisely tried to address this issue, without any convincing final answer. Biologists and scientists tried hard to define what should be considered a living organism in naturalistic terms. However, there is no consensus regarding a universal definition of life. Nowadays, biology identifies the 'living', loosely speaking, as anything capable to metabolize, eat, excrete, maintain homeostasis, grow, adapt and respond to the environment, reproduce and evolve. NASA adopted Carl Sagan's original proposal to define life as a "self-sustaining chemical system capable of Darwinian evolution" (Benner, 2010). But one could make several counterexamples of non-living entities which nevertheless satisfy several of the above criteria.

[2] It should be noted, however, that if and how the more popular term of 'morphogenetic field', introduced by the English author and biochemist Rupert Sheldrake, can be related to the conventional scientific term remains a highly controversial matter of debate. We will not consider this here.

Viruses have no metabolism and remain inactive without reproducing as long as they do not encounter a cell. And yet, they are capable of Darwinian evolution. If a virus is to be considered a life form or not is a matter of debate.

In a sense, also cars 'eat', 'metabolize' and 'excrete', but no one would recognize it resembling life. One might object that cars do not reproduce. But computer programs can simulate 'artificial organisms' –digital cellular automatons – fitting the above definition, even though only at a much lower level of complexity than that of real living cell. These 'virtual life forms' do not exist other than in a stream of bits and bytes in a codified software in computer chips and no one considers it real life forms. Reproduction, while being a common trait of all living beings, cannot be the decisive aspect individuating life: would anyone consider an infertile female or a sterile male as 'non-living'? Even though such a futuristic technology will probably still remain a sci-fi scenario for a long time to come, we could, at least in principle, imagine that sooner or later, we will be able to create self-reproducing machines. Would we then have to consider them 'alive'?

Any definition of life based on such exclusively material functionalism always fails to capture all aspects of what it is trying to define. For some reason there is something undefinable, ineffable and intangible in life, escaping a rigorous and universal scientific definition inside a purely reductionist and physicalist paradigm. The demarcation line between what is living and non-living remains unclear. Why is it so hard to define which existence is undeniable and its distinctiveness so evident?

Because of these philosophical issues, others, such as molecular biologist Andrew Ellington, simply declare that: *"There is a more obvious conclusion to be drawn from our failure to define life: there is no such thing as life. Life is a term for poets, not scientists. There are only replicators with different degrees of complexity. PS: many of you are closet vitalists"* (Christine, 2010).

We, instead, submit another even more obvious conclusion to be drawn from the failure to define life: vitalism is always lurking behind the scenes because, contrary to the accepted common narrative, there has never been any serious refutation of it. In life, we see consciousness, will, desire, motivation, cognition, mind and goal-driven behaviors. The physicalist tried hard for a couple of centuries to reduce these psychological traits to functional descriptions of material processes without success. It now resorts to the ultimate and desperate attempt: if something cannot be explained inside one's preconceived normative view, then one can still resort to the easy escapade which denies its existence in the first place, avoiding the burden to explain it.[3]

6. The mystery of sleep

The author would like to add a short personal conjecture: to the best of my knowledge no one has connected vitalism with the function of sleep. Let me outline the rationale standing behind this.

The common argument against the temptation to involve vitalism in the scientific discourse points at the metaphysical nature of presumed 'vital-forces'. If something is beyond the realm of physics, chemistry and biology, then it doesn't appear meaningful to consider its existence in a material science to begin with. Finally, by invoking principles of parsimony, one declares it as 'non-existent' altogether.

This attitude, however, ignores the fact that, while science is primarily a third-person investigation, it can orient its empiric and observational activity according to first-person experiences. A honest and dispassionate assessment reveals that, contrary to common belief, science has always been driven also by the way we perceive the world. Consciousness studies are a paradigmatic example of this. From an exclusive third-person monist materialist perspective consciousness should be considered as 'non-existent' as well. It is only because of our first-person subjective phenomenal experience that we admit something like consciousness, mind, emotions, feeling and more generally sentience as being a subject worth of scientific and empiric study. Otherwise, we would not admit these ineffable and undefinable quiddities to be part of a scientific analysis and brand it as pseudo-scientific woo.

One might object that we don't perceive 'vital energies' as being part of our inner first-person experiential realm and, thereby, the analogy does not hold. The question, however, is: do we really not perceive it? Are our inner emotional sensations, feeling, instincts, desires and all those drives we would

[3] This denialism is reminiscent of the doctrine of eliminative materialism in the philosophy of mind. Since phenomenal consciousness refuses to be cast into a strict naturalist account, the eliminativist brands our subjective experiences, such as pleasure and pain, joy and grief and the existence of our mental states, as just inexistent 'illusions'.

label as ‘vital’ of the same nature of the outer physical sensations of touch, sight, sound, smell, taste? Does the fact that both manifest inside a bodily boundary proof them to be both material? Might it be not that we are so intellectually accustomed to conflate physical and vital sensation that we misinterpret the latter for the former?

For example, does that feeling of ‘freshness’, that sensation of having ‘recharged the batteries’ we know from our personal experience after a good sleep, come only from the physical? Conversely, does that perception of a ‘lack of vitality’ we know from sleep deprivation indicate only a bio-chemical lack of energy? If so, why can’t that metabolic deficiency not be replaced by something metabolic, say by nutritional means and, instead, needs an apparently passive function as sleep?

One of the unresolved issues in modern biology and psychology remains the nature and function of sleep and dreams. Findings suggest that dreams have the functional role of processing our emotional waking-life experiences to avoid an informational and experiential overload that we could otherwise barely handle. Scientists agree that sleep has the purpose of repairing and reorganizing neural pathways, consolidating memories acquired during the waking state, filtering out redundant information, restoring the body and mind and serving other metabolic, physiological and psychological functions. As is well known, sleep deprivation leads to severe psychophysiological disorders and, in the extreme case, to death. However, there is now a growing consensus that this cannot be the whole story and that the real function and purpose of sleep remains elusive (for a review, see (Freiberg, 2020), (Frank & Heller, 2018), (Cao & al., 2020).) In fact, we do not know why all the functions of sleep mentioned above could not be performed in a waking state as well.

Puzzling is also the evolutionary origin of sleep. From a naturalistic evolutionary perspective, sleep looks like an outsider. According to Neo-Darwinism, everything – including sleep – must have evolved from natural selection and random mutations to allow for the best survival and reproduction chances. But sleep is a risky habit in a prey-predator environment, especially for those that are at the bottom of the food chain. Yet, there is no living organism, from cyanobacteria all the way to humans, that is not subjected to a circadian clock that, in brains, expresses itself as what we call ‘sleep’.

The naturalistic theory that identifies sleep as a brain cycle and a cerebral necessity is as questionable as the physicalists' mind-brain identification itself. It turns out that waking-sleep activity is not something proper only to organisms with a brain; those without a brain also show waking-sleep cycles. A sleep-like state has been observed in the cnidarian Hydra vulgaris, a small freshwater polyp, that only has a primitive nervous organization (Kanaya & al., 2020). It is now known that sleep is also present in animals, such as the jellyfish Cassiopea, that possess neurons organized into a non-centralized nerve system but have no brain. Their pulsing behavior, alternated by periods of quiescence at night, is consistent with waking-sleep cycles. When deprived of these quiescence periods, their activity and responsiveness decrease, indicative of a sleep-like state and supporting the hypothesis that sleep arose prior to the emergence of a centralized nervous system (Nath, 2017). At this point some opine that, therefore, the most plausible hypothesis is that sleep serves metabolic functions (Anafi & al., 2019). That might well be part of the solution, but we predict that there will always remain an explanatory gap, a deep mystery that refuses to disappear.

There is nothing that prevents us from advancing the hypothesis that sleep may serve as ‘recharging’ the life-sheet, or ‘vital body’ with its ‘vital energy’. When we do not sleep enough, we increasingly feel a sense of lack of vitality, energy-deprivation and inertia that no substance, food or metabolic process in a waking state can regenerate, only the sleep cycles can restore this balance. A vitalist conception that, as well known, modern science rejects, but would explain better the facts on the ground.

At any rate, this is just an example of how ignoring completely our subjective dimension, disallowing any hypothesis based also on a first-person account, may have obstructed the progress in some scientific domains. It is time to critically rethink this attitude.

7. Cell and plant basal cognition revisited

Let us now focus on the cognitive dimension of life.

Until recently it was taken for granted that any form of cognition could emerge solely from a brain or that it requires at least a neural substrate. The implicit idea is that by expressing it in terms of system theory, cognitive functions are an emergent property instantiated by the properties and interactions of the subunits of the system. Ultimately, cognition is seen as an adaptive behaviour of a complex nonlinear dynamical system, which rearranges its internal state in response to an external environment. The opposite idea of matter having in itself, a priori, mental properties was only considered by some philosophers, like G. W. Leibniz, B. Spinoza, A. N. Whitehead or William James, who expressed a panpsychist view, namely, that everything is fundamentally a form of consciousness or mind. But these speculations did not have much influence on the overall established naturalistic paradigm.

However, with time passing, there is now a growing awareness that neuroscience alone will not be able to reduce consciousness and mind inside an exclusively material scientific paradigm. The powerful diagnostic tools of functional brain imaging are insufficient, if not at all inadequate, to answer the more foundational questions regarding the nature of our inner subjectivity. Moreover, a growing amount of evidence is suggesting that at least some forms of elementary cognitive functions do not require brains or nervous systems.

Indeed, science is discovering that cells have some primitive ability to learn and associate, resembling conditioned behaviors or change it by anticipatory skills. It is within the turn of the millennium that a renewed interested in this field gained momentum, especially due to the new findings that are transforming our understanding of how mentality emerges in living organisms and even questions the very notion of 'intelligence' and 'mind' itself.

Several experiments with unicellular organisms have made it clear that conditioned behavior in single cells exists. An interesting example in this sense would be the evidence of conditioned behavior in amoebae. A Spanish group analyzed the motility pattern of the 'Amoeba proteus' under the influence of stimuli, consistent with associative conditioned behavior (De la Fuente et al., 2019). Another quite surprising behavior was (re)discovered recently in another protozoan. Already in 1906, (for a short historical account see (HMS, 2019)) the American zoologist, Herbert Spencer Jennings, noted how the ciliate 'Stentor roeselii', is capable of escalating actions to avoid an irritant stimulus. One hundred and thirteen years later, Jennings' observations were finally confirmed (Dexter et al., 2019). Indeed, this unicellular organism can 'change its mind' about how to respond to the environment in an escalation of actions that, to date, represent the most complex behavior known for a single cell.

Another quite remarkable example one could present about cellular intelligence is the abilities of the 'Physarum polycephalum', a large amoeba-like slime mold 'plasmodium'– a fungal cytoplasm containing several nuclei but enclosed in a single membrane – that can be considered as a single giant cell. It changes its shape as it crawls in search of food, as a yellow network of tube-like structures that grow a few centimeters per hour, a movement that can be captured via time-lapse recordings. This slime mold has several skills and behavioral patterns that could be labeled as 'proto-intelligent', and that one would hardly associate with such a primitive creature. For example, it can find the minimum length between two points in a labyrinth (Nakagaki et al., 2000). Further research showed that P. polycephalum can minimize the network path and complexity between multiple food sources (Nakagaki, 2004). Conditioned behavior was shown as well. When this plasmodium is exposed to life-threatening electric pulses at constant time intervals, it reduces its speed of growth or stops entirely for a while before starting to grow again. Once conditioned, it learns to anticipate the arrival of the shock if one administers a series of pulses and leaves out the last one (Saigusa & al., 2008). P. polycephalum is also able to adjust to unfavorable circumstances. If one forces it to cross an agar bridge with caffeine or quinine at toxic, but not killing, concentrations, it first slows down but, after repeated attempts, nevertheless crosses the bridge at the same speed in the absence of the irritant substances (Boisseau et al., 2016). It was believed that this was something only neural networks could do: learning to ignore negative repeated stimuli. That is, a learning process of habituation took place.

Similar abilities have been observed in bacteria. Bacteria are considered the most elementary form of life because they are prokaryotic cells. Nevertheless, it has been shown that they can sense the environment, actively move within it, target food, avoid toxic substances and meaningfully change their swimming direction. Most astonishing is their behavior when they come together and form a bacterial community, which shows surprising problem-solving abilities. Bacteria communicate with each other and coordinate gene expression, which determines the collective behavior of the entire community by a 'quorum sensing'. This leads to a collaboration that allows the community to achieve a common goal. These communities elaborate functional structures to determine if the microbes nearby are enemies and eventually secrete antibiotic compounds toxic to other species except their own, anchor in a place or stay motile, divide for the growth of the community, release spores (resistant structures used for survival under unfavorable conditions), etc. This allows them to work together to survive in stressful environments. Analogous to P. polycephalum, bacteria's collective intelligence becomes evident when they are confronted with relatively complex task-solving problems, such as route-finding in mazes and fractals (Phan & al., 2020). Cells were observed in sensing a shortcut using self-generated gradients and selecting a new minimal route (see (Tweedy & al., 2020) or for a review on bacteria's 'cognitive' skills, see also (Lyon, 2015)).

It is now a recognized fact that among living beings without a brain, an intimation of collective intelligence arises when several units or 'nodes' – unicellular organisms – connect and form an informational network. Once several of these nodes signal to each other in a complex connectome, a new order and level of functional skills arises that the single cell does not have. The single cell already seems to have some elementary cognition, but something new and qualitatively different emerges once these little entities connect in a complicated communication web.

In this regard, it might be worth noting how there is mounting evidence that non-neuronal multicellular organism also show forms of intelligence. At the turn of the millennium, terms like 'plant neurobiology' emerged, drawing parallels between the complex information processing and signaling system in plants with the animal's neuronal activity (Brenner & al., 2006), (Calvo, 2016).

Just to make some examples, it was shown that garden pea seedlings (Pisum sativum) change their foraging behavior – their direction of growth – if trained to associate a running fan with a light source, shining an hour after the fan's operation (Gagliano & al., 2016). Another example that raises important questions, not only about the predictive abilities of plants, but also about how they perceive the environment, was an experiment which analyzed the goal-directed movements of the same pea plants, which showed that the climbing plant searching for a support to attach to, exhibited an anticipatory prehensile mechanism, which gives it the ability to plan its movements *before* having any physical contact with the support (Guerra et al., 2019). There is now an extended literature that, especially in the last decade, has consistently shown how plants change behavior and adapt, respond predictively, possess some form of memory, resort to an air and underground communication system based on chemicals, have visual and acoustic signals, have learning abilities and can evaluate their surroundings, make decisions and even have a social life and cooperate with one another (for a not-too-long review, see (Trewavas, 2017).)

While the dominant mechanistic materialism can no longer deny the experimental evidence, it does not consider these phenomena as proof for what is commonly meant by 'intelligence', 'cognition', or even less a 'mind' or 'consciousness'. Speaking of 'plant neurobiology' for an organism without neurons is an obvious misnomer but, nomenclature aside, these findings fly in the face of the brain-centric belief system that there cannot be any cognition without a brain.

8. What is cognition?

These recent discoveries on monocellular or multicellular behaviors raise questions. Is a tiny unicellular creature, which swims through a fluid, hunts for its prey, avoids obstacles, has a memory and can even predict events in advance, just a simple machine? Or should we ascribe it at least some form of 'basal cognition' and eventually even some elementary form of sentience? Is a climbing plant that nervously flatters its tendrils throughout space, analyzes the environment, grows towards a support it apparently 'sees' and begins to grab for it before even touching it, only a machine driven by a chemical reaction, or something we could ascribe a form of cognition?

As the notion of life, the definition, nature, and origin of what is commonly called 'cognition' is yet another unresolved issue that led to considerable debates (for a couple of recent works on this matter see (Lyon & al., 2021) and (Regolin & Vallortigara, 2021).) We maintained an understanding of cognition as the action or faculty of learning, decision making, sensing and responding, communicating, information processing, having memory and agency and associative skills, including high-level forms of cognition that result in analytic thinking and reason, known as the 'mind'.

The system theory of autopoiesis, from Chilean biologists Humberto Maturana and Francisco Varela (Maturana & Varela, 1980), refers to the process of self-creation and self-preservation of living systems, where cognition is seen as a self-referencing mechanism determined by a structural coupling to the environment. It was, and remains, a working hypothesis that, so far, did not lead to a successful theory satisfyingly describing cognitive systems and what cognition really is. It works on the line of Gilles Deleuze, who considered the tendency of life to move towards greater self-organizing complexity that maximizes difference with its dynamic potentiality to develop beyond its actuality and renamed it ‘vitality’ ((Deleuze, 1966), (Grosz, 2004)). This sounds more like a terminological rephrasing of something that, however, does not tell us much about the origin and raison d’étre of what it is describing.

The science of biosemiotics, a branch of biology which interprets living processes as production and interpretation of signs, codes, information, meanings, habit formation and their communication in the biological realm (for an introductory essay see (Else, 2010)), came somewhat closer to the idea of cognition as a fundamental aspect of reality but refrains from making the decisive step towards the reversion of the naturalistic paradigm.

All these approaches maintain and continue to nurture the naturalist instinct that desires to reduce all complex systems dynamics to mere elementary processes. The (more or less implicit) premise that is not willing to give way to other possible interpretations is the reductionist view where we have to recast everything into a causational chain determined by a system of processes that lead to cognition as an emergent secondary epiphenomenon – that is, something that works by a unidirectional bottom-up process as: aggregation of microscopic fundamental interacting units into large scale network processes → information/code/semantics → cognition. Considering the plausibility of the hypothesis that goes the other way around is rarely addressed (for an interesting exception see (Marshall, 2021)), namely, that cognition is fundamental, even more fundamental than matter and that the causational chain works as: cognition → semantics/code/information → aggregation of microscopic fundamental interacting units into large scale network processes.

We believe that there is a sufficient amount of observational data that allows us to posit that cognition is not just an emergent behavior determined by a complex network of processing units, rather it is an inherent and basic feature of living matter itself. There is not only a life-principle, but also a mind-principle.

Conclusion

We presented some arguments and scientific evidence aimed at reviewing critically the wide held belief that vitalism is dead, with mentality having no place in nature other than an emergent epiphenomenon. At closer inspection, one realizes that there is no end in sight for the search of a mechanistic explanation that reduces life to non-life and dismisses Bergson’s ‘creative evolution’ or Driesch’s entelechy as self-organizing principles, furnishing any naturalistic foundation of the emotional and cognitive behavior in living organisms. The reasons why these intellectual currents continue to be dismissed do not rely on any rational or scientific basis but have to be understood in its cultural and historic context. Life and mind, both to be distinguished from consciousness, but at the same time, are the two aspects of its workings, may well be two fundamental inherent properties that emerge in and through matter rather than by matter. There is nothing in science that prevents us from seeing will and cognition as powers of a subconscious nature trying to express itself in these different forms of sentience.

Life and mind, as two distinct aspects of reality, both have consciousness as its origin and matter as its supporting basis: these new findings not only do not disprove philosophical idealist or vitalist speculations, but even encourage an integration between some form of idealism and vitalism. Perhaps we will soon find ourselves speaking again in teleological terms of a ‘plan’ a ‘will’ or an ‘idea’. And we might think the other way around recognizing consciousness, will, desire, motivation, cognition, mind and goal-directedness as fundamental principles, not emergent appearances, that impel the organization and function of living matter itself. The exclusion of vital forces and mentality as a foundation of all life in a teleological theoretical framework was also partially vitiated by a too simplistic identification between consciousness, life and mind. A conflation that was embraced by the few supporters of the vitalist, idealistic and teleological camp as well. Nonetheless, the dismissal and denial of these paradigms might have been too premature, and they may soon find their way back into our world-constructs, at least in the metaphysical discussions, as idealism, panpsychism and various forms of cosmopsychism are already doing. The phenomenon of life emerging from non-living matter is no less perplexing than that of consciousness emerging from non-conscious matter. There is not only a hard problem of consciousness but also a hard problem of life. The reason why the mind-body problem received so much attention while almost none was devoted to the ‘life-body problem’ hasn’t its roots in a sound scientific falsification but in a too quick collective dismissal that considered it a closed case while, upon closer scrutiny, reveals itself an open issue more than ever.

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