"ACTIVE INFORMATION" – A MODERN REVIVAL OF ARISTOTLE'S "FORMATIVE CAUSE", APPLICABLE IN PHYSICS, BIOLOGY, PSYCHOLOGY AND MEDICAL ANTHROPOLOGY

Peter HEUSSER

ABSTRACT. ***Reductionism since the 19th century causally explains all events in the cosmos by physico-chemical laws and forces only. This view dominates until now and denies immaterial forms of reality. However, this reductionist world view may turn out to be just a "belief" as can be seen by the findings and conclusions of Johann Wolfgang von Goethe, Werner Heisenberg, Carl Friedrich von Weizsäcker, Norbert Wiener, Walter Heitler, Hans Primas and others. A special accent is put on David Bohm's and David Peat's proposal of "active information" as a third real factor besides matter and energy. Hence, ideas as active causes become a natural part of physical explanations. This is equivalent with a modern revival of Aristotle´s "formative cause". The concept of information in modern biomedicine (including the conception of self-organization) is given a substantial consideration and analysis in the work. The author substantiates that it is the form, not the substance which provides the essence of an organism. Substantially, the causa formalis is not only applicable in physics and biology, but also in psychology and medical anthropology. In conclusions, the author claims that Aristotle's "causa formalis" is a universally applicable concept which allows for a conceptual understanding not only of the essence of matter in modern physics, but also of the hierarchical organization of nature in minerals, plants, animals and humans, and in the inner build-up of the human being with its emerging properties as a physical, living, conscious and self-conscious being. This provides the conceptual basis for a modern philosophical and medical anthropology which refrains from reductionism but acknowledges the clearly discernible phenomenological levels of body, life, soul and spirit in their own right and corresponds to Aristotle's anthropology, but in a modern sense.***

KEYWORDS. ***Causal explanation, Aristotle´s causa formalis, causa finalis, active information, emergence, hierarchical organization, holism, medical anthropology.***

Reductionism since the 19th century implies that the world with all its details can be causally explained by physico-chemical laws and forces only. The properties of life in organisms, the appearance of consciousness in animals and humans, and finally the specific cognitive abilities of human beings are theoretically explained by complex interactions of molecules. In consequence, immaterial forms of reality are denied, and the spiritual is thought to be a cultural construct without ontological significance. Thus, only matter is considered to be "real", and the traditional "beliefs" in immaterial forces responsible for life, in the existence of a "soul", and in the existence of the human spirit and spiritual entities in the cosmos are discarded, at least I the realm of science.

However, this reductionist world view may turn out to be a "belief" itself as can be seen from the development of the physical sciences. 20th century physics has led to the complete abandonment of the classical notion of matter. The core of matter no longer consists of space-filling corpuscles, but of quanta of forces whose essence has been boiled down to nothing but mathematical structures, i.e. to pure laws. So Werner Heisenberg in his famous book "Physik und Philosphie": "For the quantum physicist the thing-in-itself is, if he uses this concept at all, is ultimately *a mathematical*

structure. But this structure is, in contrast to Kant, indirectly inferred from experience" (Heisenberg, 1973, 70). This structure corresponds more to the "*ideas of Plato"* than to the corpuscles of Democritus (Heisenberg, 1973, 48–52) or, in an Aristotelian sense, to the immaterial "form" within "matter": "Therefore, the smallest particles of matter are not primarily existing things as in the philosophy of Democritus [or the atom models of the 19th century, PH], but they are mathematical *forms*. It becomes obvious that the *form* here is more important than the *substance* which comprises this form, or appears in this form, respectively" (Heisenberg, 1973, 50–51).

Similarly, Carl Friedrich von Weizsäcker wrote in an article in "Deutsches Ärzteblatt" of 2000, in which he calls upon the German physicians to overcome old thinking habits: "Already in the 1920ies it [quantum physics, PH] has shown that the atomic structures do not correspond to the models of classical physics any more, as materially conceivable corpuscles in the sense of Descartes' *res extensa*. Up till now they have been described without contradiction only as mathematical structures" (Schmahl & von Weizsäcker, 2000). And one of von Weizsäcker's pupils, Thomas Görnitz has recently put forth the idea that matter is ultimately nothing but "information" or "spirit" ("Geist") (Görnitz & Görnitz 2008). But what is information? Norbert Wiener, the founder of modern cybernetics, answers: "Information is information, not matter or energy. No materialism which does not admit this can survive at the present day" (Wiener, 1948, 155).

In other words: even if the *appearance* of matter is "matter" as something "sense-perceptible", its lawful *essence* is not "matter", nor (material) "energy"; but lawfulness, information, or "spirit". Walter Heitler, who was professor for Theoretical Physics at the Swiss Institute of Technology (ETH) in Zürich, wrote in 1972 with respect to physical laws: "They are formulated in a strict mathematical form, and the physical processes follow them. A mathematically formulated law is something spiritual ["geistig"]. We can it name so because it is the human spirit that cognizes it. The term 'spirit' may not be so popular today, when an overwhelming materialism and positivism put forth their sometimes quite harmful blossoms. But exactly for this reason we should gain clarity about what a law of nature and the cognition of that law are. Nature follows this non-material element, the law. Thus, also spiritual elements root in nature. To these pertain the mathematical contents which are necessary for the formulation of the law […]. On the other hand, the scientist who is gifted to make a discovery, is capable of cognizing this element that penetrates nature. And here we can see the connection between the human cognizing spirit and the transcendent elements existing in nature. We best express this point by using a platonic expression, although Plato did not know this form of laws of nature yet. In this sense the law of nature is an archetype, an 'idea', – in the sense of the Greek word *Eidea*; to which nature obeys and which can be *conceived* by the human spirit" (Heitler 1972, 14–15).

But these "laws", "ideas" or "informations" of matter can – in matter as it exists *out there* in nature or in the laboratories – not be the pale and abstract thoughts as which they appear in our minds when we think them. Physical processes *follow* them

actually, so there must be some kind of activity or force with which the actual manifestation of these laws is realized. In other words, "activity" pertains to these laws; the laws themselves must to be "active" entities. For such reasons, the 20th century physicists David Bohm and David Peat have proposed "*active information"* as a third real factor of nature, besides matter and energy (Peat 1999). In other words: ideas as active causes have become part of physical explanations.

This is equivalent with a modern revival of Aristotle´s "formative cause", albeit in the realm of physics: the material cause (matter) and the effective cause (energy) are complemented by the formative cause ("*active information*"). The surprising fact is that this revival is not due to the continuation of Aristotle's position within the philosophical tradition; it is the consequence of empirically based modern physics, the science which professionally deals with the question what matter is all about.

However, the concept of formative cause is applicable also in biology and psychology. This becomes clear when considering the phenomenon of *"emergence"* in the hierarchical organization of nature. Superordinate "wholes" exhibit *new* and *other* properties than their subordinate "parts", whereby the properties of the whole cannot be deduced from those of the parts; they "emerge" as something new and unpredictable. But the emergent whole has *its own* laws as opposed to the laws of the parts.

This is already true for the build-up of matter itself: atoms appear to be composed of elementary particles, molecules of atoms and macromolecules of molecules. Bur each level of this hierarchical organization of matter is *emergent* from the lower one: its laws and properties are something new which is *compatible with* those of its subordinate parts and *depends* on them, but cannot be *derived* from them (Primas 1991). This is why Hans Primas, who was professor for physical chemistry at the Swiss Institute of Technology (ETH) in Zürich, consequently refutes the reductionist paradigm according to which matter is composed of parts, and puts forth a new, holistic, model of matter: "If we hold quantum mechanics to be a good theory of matter, then the statement 'matter is built-up of elementary particles' scientifically wrong. Decisive is not the fact that the atoms of the chemist can be split further […], but that *material reality is a whole that is not composed of parts at all.* […] Quantum mechanics is the first logically consistent and mathematically formulated holistic theory. The concept of holism in modern physics is much more encompassing than the holistic attempt in other fields of natural science" (Primas 1992, 9–11).

Yet this is not entirely correct. Historically, the first holistic natural scientific theory has been put forth in *biology*, or more precisely, in Goethe's work on morphology (Amrine et al. 1987). Indeed, organisms are biological systems or "wholes" in which the organization of the whole demonstrably governs the functions and structures of its parts and exerts top-down causality on them [Kim 1999, 28]. Of course, all biological processes can ultimately be dissected in networks of molecular interactions. But the more detailed the factual knowledge about molecular biology becomes, the more it becomes clear that all these molecular interactions and interaction cascades are highly *"orchestrated"* in a spatially and temporally coordinated manner (Fox Keller 2000). Insofar as the parts *are* coordinated or

orchestrated, they are the law-*receiving* elements, whereas the organization as such is the law-*giving* principle. And as this coordination is *really* effectuated, the law-*giving* principle must be an *active* principle, i.e. "active information" or a causa formalis in the Aristotelian sense. Additionally, this law is also a "causa finalis": it enacts itself teleonomically in time such as in the growth of embryos or in wound healing.

In biology, the concept of information has often been restricted to genetic information; and genes were thought to contain all the information necessary for the organization of an organism. But strictly speaking, genetic information refers to nothing but the lawful sequence (organization) of amino acids on the protein chain; and this only a small portion of all biological information. The information of all other higher-order spatial structures and especially the content of all temporal structures in which the proteins are embedded are as such *not* encoded in the genes. Encoded is only the information for proteins that become *parts* of emergent higher order structures or for proteins that *catalyze* the realization of such structures. Thus, genetic information provides only the information for material *conditions for the manifestation* but not for the *content or information* of the higher order structures. These are *emergent* in nature. For this reason, a complete concept of biological "information" would have to refer to the complete spatial and lawful *organization* of the organism, of which genetic information is but a small portion. It is this overall organization, the "idea" of the organism, which is meant by Goethe in his concept of the organic "type" (Goethe 1950). It is *an active idea* that enacts itself, if the necessary conditions and substrata are given. This is actually the true meaning behind the concept of *"self-organization"*: The organization as such can enact itself in the corresponding substrates because it is a causa formalis or finalis; the substances of the substrate however can never be the cause for the emergent organization or only in the sense that they provide the causa materialis and the (material) causa efficiens for the organization (Heusser 2011). But the organization as such bears an ontological value in itself. This is the true reason why Ernst Mayr can formulate for the organism in a similar way as Werner Heisenberg has formulated for matter: it is the *form*, not the substance which provides the essence of an organism: "The difference between inorganic matter and living organisms does not lie in the substance of which they consist, but in the organization of biological systems" (Mayr 1984, 50). This makes only sense when the form as such is a real or "active" element of the organism, a causa formalis or finalis in the sense of Aristotle.

But the causa formalis is not only applicable in physics and biology, but also in psychology: In animals and humans the properties of consciousness are as emergent from the properties of life, as life is emergent from the non-living. In-as-far as soul-life exerts top-down causality on organismic functions such as in behavior, physiognomy and even neuronal plasticity, the laws of the soul can be viewed as "active forms" or "informations" in the sense of Aristotle. In physiognomy for example, the facial and gestural behavior of animals are a direct expression of their inner affective or volitional states which has been carefully described already by Charles Darwin (Darwin 1998). And according to Adolf Portmann also the specific shapes, structures and external make-ups of animals' organisms bear physically the

expression of the trait properties of inner their inner soul life (Portmann 2006). This corresponds to Thomas Aquinas' famous dictum "anima forma corporis est". Indeed, the mind-body interaction can be better understood if it is not interpreted as the *external* interaction of two causae efficientes or materiales as in the mechanistic view of René Descartes, but as the completely *inner* shaping of a substrate (causa materialis) by a causa formalis that *inwardly* penetrates the substrate and gives it a higher, emergent form (Heusser 2011).

Human beings are often seen as the highest class of animals. Indeed, they exhibit basically the same or at least extremely similar physical, biological and psychic properties as higher animals. But *in addition* to that humans clearly exhibit unique properties through which they can specifically discerned from animals. This includes the deliberate control of thoughts, emotions, actions, planning for the future, self consciousness and self reflection, language, certain aspects of imitation and social learning, episodic memory, theory of mind, and others (Gazzaniga 2008). The single theme that ties all these faculties together is the specifically human capacity of self-conscious willful thinking (Heusser 2011). Animals and humans have their soul, but in addition to that humans have their spirit, their innermost individual entity or "I" which emerges from the soul and is able to control the soul with its emotions and thrives as well as their physiognomic expressions. For this reason one could complete Thomas Aquinas' dictum: "Spiritus forma animae et corporis est". In Aristotelian terms: the human spirit is the causa formalis which can – in certain aspects of life and at certain stages of inner development only, of course – actively control and form the actions of lower causae formales.

In other words, Aristotle's "causa formalis" is a universally applicable concept which allows for a conceptual understanding not only of the essence of matter in modern physics, but also of the hierarchical organization of nature in minerals, plants, animals and humans, and in the inner build-up of the human being with its emerging properties as a physical, living, conscious and self-conscious being. This provides the conceptual basis for a modern philosophical and medical anthropology which refrains from reductionism but acknowledges the clearly discernible phenomenological levels of body, life, soul and spirit in their own right and corresponds to Aristotle's anthropology, but in a modern sense. (Girke 2010; Hartmann 1964; Wallace 1882).

References

Amrine F, Zucker FJ, Wheeler H (1987). Goethe and the Sciences: A Reappraisal. Reidel, Dordrecht.

Darwin C (1998). The Expression of Emotions in Man and Animals. Oxford University Press, New York.

Fox Keller E (2000). The Century of the Gene. Harvard University Press, Cambridge MA.

Gazzaniga MS (2008). Human. The Science behind what makes us Human. Harper Collins, New York.

Girke M (2010). Innere Medizin. Grundlagen und therapeutische Konzepte der Anthroposophischen Medizin [Internal Medicine. Fundamentals and Therapeutic Concepts of Anthroposophic Medicine]. Saulmed; Berlin.

Goethe JW (1950). Erster Entwurf einer allgemeinen Einleitung in die vergleichende Anatomie, ausgehend von der Osteologie [First Draft of a General Introduction into Comparative Anatomy, based on Osteology]. In: Johann Wolfgang Goethe. Sämtliche Werke, Vol. 17, Artemis, Zürich, pp 231–269.

Görnitz T, Görnitz B (2008). Die Evolution des Geistigen. Quantenphysik – Bewusstsein – Religion [The Evolution of the Spiritual. Quantum physics – Consciousness - Religion]. Vandenhoeck & Ruprecht, Göttingen.

Hartmann N (1964). Der Aufbau der realen Welt [The Foundation of the Real World]. Walter de Gruyter, Berlin.

Heisenberg W (1973). Physik und Philosophie [Physics and Philosophy]. Ullstein, Ulm (emphasis added).

Heusser P (2011). Anthroposophische Medizin und Wissenschaft. Beiträge zu einer integrativen medizinischen Anthropologie [Anthroposophic Medicine. Contribution for an Integrative Medical Anthropology]. Schattauer, Stuttgart

Kim J (1999). Making Sense of Emergence. Philosophical Studies 95: 3–36.

Mayr E (1984). Die Entwicklung der biologischen Gedankenwelt [The Development of Biological Thinking]. Springer , Berlin.

Peat FD (1999). Active Information, Meaning and Form. Frontier Perspectives 8: 49–53.

Portmann A (2006). Die Innerlichkeit – Die Weltbeziehung und das Erleben [Inner Life – The Relation to the World and the Experience]. In: Senn DG (ed.): Adolf Portmann. Lebensforschung und Tiergestalt. Ausgewählte Texte. Schwabe, Basel, pp 60–73.

Primas H (1991). Reductionism: Palaver without Precedent. In: Agazzi E (Ed.): The Problem of Reductionism in Science. Kluwer Academic Publishers, Dordrecht, Boston, London, pp 161–172.

Primas H (1992). Umdenken in der Naturwissenschaft [Paradigm Shift in the Natural Sciences]. Gaia 1: 5–15.

Schmahl FW, von Weizsäcker CF (2000): Moderne Physik und Grundfragen der Medizin [Modern Physics and Fundamental Questions in Medicine]. Deutsches Ärzteblatt 97 (4). A165–A167.

Wallace E (1882). Aristotle's Psychology in Greek and English, with Introduction and Notes by Edwin Wallace. Cambridge University Press.

Wiener N. (1948). Cybernetics. Wiley, New York.