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INFORMATION AND COMMUNICATION

ABSTRACT

After the Enlightenment of the 18th century concern for the lonesome individual and the need for communication gave birth to the academic disciplines of psychology and communication science. Positivism and the linguistic turn explored the distinction of what is observable and invisible. Information assumed a place alongside matter and energy in the classical formulation of Wiener: "Information is information." The problem of information and body-plans appears to be a key element in the tradition of vitalism. Rainer Schubert-Soldern identifies form with the "order" of the cell and more recently the ID movement (Intelligent Design) addressed the problem of an increase in information presented by the Cambrian explosion. However, having assumed the current practice of viewing information as an object for natural scientific investigation is radically questioned by Peter Janich when he criticizes this Legend and its icons. The impasse involved in this Legend also entails a challenge to the status of natural laws. Physical laws as conditions for what is physical are not themselves physical in nature. Janich argues that we are inclined to use information in a metaphorical sense as if it is a natural scientific object of investigation. Alternatively one should commence with communication between more than one human actor because it is only within such a communicative context that one actor can inform another actor and that information becomes meaningful. Schuurman is therefore correct when he asserts that at bottom information is lingual.

Keywords: Information; communication; natural scientific object; metaphor; naturalising prejudice; physicalism; body-plan; Cambrian explosion; the lingual nature of information

During the 19th century the general understanding of the various academic disciplines by and large settled for focussing on the distinction between natural sciences (*Naturwissenschaften*) and that of the humanities (*Geisteswissenschaften*). Distinguishing between these scholarly fields experimented with different options. Within the Baden School of neo-Kantian philosophy, Windelband introduced the idea of nomothetic natural sciences and idiographic cultural sciences. Rickert opted for a different terminology, for according to him the natural sciences proceed in a generalising way whereas the cultural sciences were supposed to be individualising.

When the era of conceptual rationalism entered the scene, particularly during the Age of "Reason" (the Enlightenment of the 18th century – with Immanuel Kant as its main advocate), the relation between what is individual and universal turned out to be an unsolved problem. With the rise of historicism during the beginning of the 19th century the limitation of conceptual knowledge to what is universal prompted a search for alternative avenues, which were respectively found in the nature of sensory perception and language. Positivism and neo-positivism explored the ability of sensory perception to grasp what is individual, while the “linguistic turn” chose for language because through the use of language it is also possible to capture what is individual in a unique deictic way.

This line of development intersected with another one. By the end of the 19th century the differentiation of society, particularly as a result of the industrial revolution, resulted in an increasing alienation of the individual person. Within the work place a distance emerged between the labourer and the end-product of the production process. The French sociologist, Emile Durkheim, underscored this development by highlighting the fact that the communal experience of Roman Catholics caused less instances of suicide than what was found within Protestantism.

The individual appears to have lost a proper self-understanding. Combined with the increasing process of secularisation, individuals became less dependent upon the pastor, which in turn gave the newly emerging profession of psychologists a chance to step in. In a certain sense psychology developed as a spin-off of the individual who no longer understood herself or himself. Yet after a number of decades it was clear that the situation had not improved and that individuals were not merely increasingly alienated but also no longer understood each other. This provided Western society with another new option, seized upon by the rise of the theme of communication. Not understanding each other may be cured through communication. However, human communication always presupposes meaning, oftentimes recognised by linguists as the “invisible” element of language (the visible sign and its invisible meaning). The emergence of information theory is of a relatively recent origin – a feature shared by the equally recent emergence of the scholarly discipline Communication Science. The name of Shannon is associated with the rise of information theory, with particular reference to his articles in *The Bell System Technical Journal* (July 1948 and October 1948). It appeared as “A mathematical theory of communication” (see Shannon 1948).[1]

INFORMATION – MATTER – ENERGY

The basic approach to information immediately rejected the identification of information with matter and energy. It therefore did not take long before a close affinity was observed between meaning and information, because, according to Wiener: “[I]nformation is information nor matter or energy” (Wiener, quoted by Kiontke 2006: 232). Kiontke explains his view as follows:

> Information is also a wholly special entity of being. It is neither matter nor is it energy, both merely serve as bearers of information. If matter or energy is passed on then we have the resulting collection of matter or energy once more. But if we pass on information then we do not lose it. It is therefore possible to multiply information almost at will without the need to absorb further information (Kiontke 2006: 232).[2]

IMMATERIAL FORM: THE VITALIST LEGACY

This statement raises a question regarding the vitalist distinction between form and matter – to which we will return in connection with the analysis presented by Peter Janich of the terms “information” and “informing”. It represents a legacy dating back to the basic orientation of Greek philosophy as it is directed by the ultimate motive of matter and form. In order to account for the persistence of changeful entities, Plato postulated a supra-sensory realm of eternal static ontic forms – his famous *world of ideas*. Aristotle transformed these ideas into the universal forms inhering in material things, providing them with their substantial unity. *This* house is different from *houseness*: “the being of house is not generated, but only the being of *this* house” (Aristotle 2001: 807). Yet in the thought of both Plato and Aristotle the ultimate dualism between matter and form was not bridged. Plato eventually realised that he could not introduce a *form* for what is form*less*; he later attempted to bridge the gap by introducing “ideal matter”. Also in the thought of Aristotle the opposition between the original formless matter and the form principle was not reconciled. Happ discerns in Aristotle’s thought an original split: “matter in itself” [*reine Hyle*] and “reine Form” (pure form – see Happ 1971: 799).

TELEOLOGY AND BODY-PLANS

Within the field of biology this notion of form was connected with the idea of goal-directedness (teleology) and with the conception of an *immaterial* (ideal) *body-plan*. Ray and Linnaeus continued the legacy of Plato within modern biology. In general their orientation is known as *idealistic morphology*. The best known more recent representative of this idealistic morphological approach is found in die work of Wilhelm Troll from Austria. In a quasi-platonic sense he interprets the Platonic forms as arch-typical patterns. He assumes the existence of intuitively articulated primal units, viewed as the subject-matter of biology (see Ungerer 1966: 232). In exploring this path Troll continues the preference of Goethe for a “Gestalt”. Yet it should be kept in mind that according to Goethe “Gestalt” is not rooted in law – rather law is rooted in “Gestalt”. Within idealist morphology a primal leaf or a primal plant is designed in which basic typological characteristics are present. One of the consequences of this position is that Troll continues to believe that morphology determines the possibility of descent, and not the other way around: “It is not the descent which is decisive in morphology, but rather the opposite: morphology has to decide about the possibility of descent” (Zimmerman 1968: 49).[3]

GESTALT AND FORM

The idea of a Gestalt reflects the platonic legacy within biology. Particularly vitalism and neo-vitalism draw a distinction between “organic form” and the parallel characteristics of organisms. The neo-vitalist botanist, E.W. Sinnott, writes that “[Von] Uexküll and others have emphasized this idea and regard organic form as essentially an independent aspect of an organism, parallel with its matter and energy”.[4] He continues that neo-vitalism holds that “form” is “a basic characteristic of all living things”

(Sinnott 1972: 51). It relates to the broader perspective that we may discern “regions of orderly diversity”. He contemplates a hierarchy from “atoms, molecules and crystals to stars and galaxies”. The “formative quality” which is “particularly conspicuous among living things” differs from “particles and the material substances they produce”.

To this Sinnott adds another dimension when he considers form to be constituted by the orderly patterns obtained between particles. It is also designated as relations among particles. Form therefore does not concern the material particles themselves, but rather interrelations. Elaborating this approach anticipates key elements eventually articulated in more depth by the contemporary intelligent design (ID) movement. On the one hand it revives Greek notions of an *indivisible whole* found in the metaphysics of being of Parmenides[5], and on the other its “changing and creative” nature relates to the general vitalist idea of a body-plan. Sinnott believes that form “is a continuous entity and cannot be divided into pieces” (Sinnott 1963: 199).

Johannes Haas developed this view further by emphasising that every living thing in the elaboration of the course of its life obeys an inherent law or programme. He designates the programme not as a body-plan but as a life-plan – a term also frequently used by Stephen Jay Gould. Haas recognises within the life-plans the blueprints of each of their expressions, including the “genetic plan” for their succession, the functional plan for their activities, as well as the behavioural plan for all their “acts” (Haas 1974: 336). According to Haas, there is a similarity between life-plans and laws because both exhibit an ideal being (*ideales Sein*). It entails that it is impossible to explain them in a physico-chemical way: “Physical-chemical forces and laws are in themselves unable to bring forth the structures of meaning which we identify as the life plan, and even less can it produce a non-material bearer of life plans” (Haas 1974: 355).

THE ABYSS BETWEEN THE NON-LIVING AND THE LIVING

According to Haas, bridging the abyss (*Kluft*) between the non-living (*Unbelebten*) and the living (*Lebendigen*) must conform to the following conditions: (1) It must dispose over a creative intelligence exceeding everything imaginable [*Es muss eine alles Vorstellbare überragende schöpferische Intelligenz besitzen*], for only such a Being can produce a meaning-structure such as what we recognise as “Lebenspläne” (designs of life/vital plans) (Haas 1974: 355-356), and (2) It must be capable of realising the “life plans” of organisms, namely it must have power over being as such (*ibid.*).

In agreement with Driesch, the neo-vitalist biologist Rainer Schubert-Soldern also substantiated his view with biochemical arguments in which the so-called principle of wholeness plays a key role. He holds that the cell depends on actualising a dual potential: “(a) the ‘form’ or order of the cell, and (b) the chemical laws governing molecules. ... This principle of order may be called the ‘active potentiality’ of the material parts” (Schubert-Soldern 1962: 102). His view of the principle of order returns to Aristotle: “Hence the Aristotelian concept of entelechy corresponds exactly with the principle of order, which we see at work making the cell into a whole. It is a principle of wholeness which forms a unity from parts which would otherwise go their separate ways. Thus a hologenous system is born” (Schubert-Soldern 1962: 113).

The central position of the idea of *Ganzheit* (wholeness) and form within the vitalist legacy in biology is linked to the idea of an immaterial vital force already found in the thought of Aristotle (he called it "entelechie"). Whatever was introduced beyond matter or energy was assigned with the capacity to structure living entities in their peculiar forms. We noted earlier that the term best serving this purpose is captured by the idea of a body-plan.

INFORMATION THEORY AND THE CAMBRIAN EXPLOSION

When information theory emerged during the late 1940s the discovery of the spectacular structure of DNA was not yet known. Once this discovery was made new challenges surfaced, particularly in connection with the data of what became known as the Cambrian explosion.[6] Sterelny highlights the nasty fact, namely that about 530 million years ago most "major animal groups appeared simultaneously". He continues: "In the 'Cambrian explosion', we find segmented worms, velvet worms, starfish and their allies, molluscs (snails, squid and their relatives), sponges, bivalves and other shelled animals appearing all at once, with their basic organization, organ systems, and sensory mechanisms already operational. We do not find crude prototypes of, say, starfish or trilobites. Moreover, we do not find common ancestors of these groups" (see Sterelny 2001: 89-90; also see the later edition, Sterelny 2007: 116). The 20 to 40 million years allocated to the Cambrian era have now been reduced to 5 to 6 million years (Meyer 2013: 72). We note these data only in passing because our focus is rather on the complexities involved in accounting for the information-increase required by new animal body-plans.

In his mathematical theory of information, Shannon assumes that improbability communicates more information. He proceeds by looking at the probability of any one character from the English alphabet occurring in a sequence of other such letters (including a space) – it is 1 in 27. In all cases Shannon therefore assumes a 27-symbol "alphabet" (the 26 letters and a space). Different orders of approximation are considered, such as a Zero-order approximation (symbols independent and equiprobable): XFOML RXKHRJFFJUJ ZLPWCFWKCYJ FFJEYVKCQSGHYD QPAAMKBZAACIBZLHJQD, a First-order approximation (symbols independent but with frequencies of English text): OCRO HLI RGWR NMIELWIS EU LL NBNESEBYA TH EEI ALHENHTTPA OOBTTVA NAH BRL – and so on (Shannon 1948: 7).

Clearly, the account had to revert to discrete units (compare "bits" – with 0s and 1s as their basis) – showing that also a binary alphabet can communicate an unlimited amount of information. Within Shannon's theory additional information is communicated when there is an increase in the number of improbabilities. Considering a specific sequence of characters shows that improbability may increase exponentially with the number of characters in the sequence.

Meyer explains that information scientists "measure such informational increases through a unit they call a *bit*. A bit represents the minimum amount of information that can be conveyed (or uncertainty reduced) by a single digit in a two-character alphabet." The probability of either a zero or one arising in a sequence of binary characters is

1 in 2. In Shannon's theory the presence of the more improbable character conveys more information.[7]

A MEANINGFUL SEQUENCE VS USELESS GIBBERISH

However, in his investigations regarding the increase in information needed for more complex body-plans, Stephen Meyer notes that the application of Shannon's information theory to molecular biology to some degree has obscured an important distinction regarding the type of information found in DNA: "Although Shannon's theory measures the amount of information in a sequence of symbols or characters (or chemicals functioning as such), it doesn't distinguish a meaningful or functional sequence from useless gibberish" (Meyer 2013: 166-167). Meyer explains this by using the following example: "we hold these truths to be self-evident" and "ntnyhiznslhtgeqkahgdsjnfplknejmsed". Although these two sequences could be imagined as being random, their Shannon information content is the same. Nonetheless the implicit qualitative difference between them is concealed because it is not captured by the Shannon measurement. Whereas the first "meaningful sequence performs a communication function … the second does not" (Meyer 2013: 167). Warren Weaver, one of Shannon's close collaborators, elucidated in 1949 that the special mathematical sense of the word "information" should not be confused with its everyday usage of meaningful or functional communication (Meyer 2013: 167).

THE COMPLEXITY OF LIVING ENTITIES

A consideration behind this distinction concerns the complexity of living entities. In spite of having numerous differentiated internal functions, a (single-celled) eukaryote represents still merely one single cell-type. The complexity present in differentiated (prokaryote) multicellular living entities requires organs capable of performing more diverse functions since each of them needs multiple specialised cell-types. It is therefore understandable that examining the cell-types of different living things could be used to assess a different degree of complexity – a suggestion made by James Valentine.

Of course such new cell types are in need of many new and specialised proteins. Meyer mentions an "epithelial cell lining a gut or intestine" … "which secretes a specific digestive enzyme" … and this enzyme in turn "requires structural proteins to modify its shape and regulatory enzymes to control the secretion of the digestive enzyme itself". The upshot of this is that the construction of novel cell types typically requires building novel proteins, which requires assembly instructions for building proteins – that is, genetic information. Thus, an increase in the number of cell types implies an increase in the amount of genetic information (Meyer 2013: 162).

The moment the term "type" is used, another implicit distinction surfaces, namely that between *modal* (aspectual) laws and *type* laws. The former are universal in the sense that they pertain to all possible classes of entities, whereas the latter (type laws) evince a specified universality insofar as they only apply to a limited class of entities.[8] Stafleu (1980: 11) explains:

> Whereas typical laws can usually be found by induction and generalization of empirical facts or lower level law statements, modal laws are found by abstraction. Euclidean geometry, Galileo's discovery of the laws of motion ..., and thermodynamic laws are all examples of laws found by abstraction. This state of affairs is reflected in the use of the term 'rational mechanics,' in distinction from experimental physics.

EPIGENETIC INFORMATION

Although it has been assumed for some time that natural selection acting on random mutations was sufficient to explain the rise of new complex body-plans, it more recently appeared that in addition to an unparalleled explosion of genetic information another type of information is required which is not stored in genes. It is called epigenetic information and extensively discussed by Meyer in Chapter 14 of his work on *Darwin's Doubt* (see pages 271-310 – *The Epigenetic Revolution*).

Neo-Darwinians concede that the genesis of the first living entity is a mystery. Yet they still believe that it occurred "spontaneously" by means of purely material processes. The key issue concerns the extreme improbability of such a process and in particular the absence of any clues as to how the information found in living entities came into being. The "hardware" (material) does not explain the "software" (such as ordered DNS sequences, epigenetic information or complex proteins). Interestingly the equally mysterious appearance of new animal *phyla* during the Cambrian explosion now turn out to be of an epigenetic origin, not stored in genes. What is more baffling is that similar information sequences do not affirm common ancestor genes. Recent "genomic studies which reveal that hundreds of thousands of genes in many diverse organisms exhibit no significant similarity in sequence to any other known gene" (Meyer 2013: 215).

Meyer also mentions that ORFan genes (derived from "open reading frames of unknown origin") have "turned up in every major group of organisms, including plant and animals as well as both eukaryotic and prokaryotic one-celled living entities. In some organisms, as much as one-half of the entire genome comprises ORFan genes" (Meyer 2013: 216). In the absence of homologs it is not possible to relate ORFans to any common ancestral gene, increasingly acknowledged by biologists who now want to "explain" the origin of such genes through *de novo* ("out of nowhere") origination (*ibid*.). It is striking that the mystical realm of "coming from nowhere" is intimately related to the information specified by the type-law of animals. It should therefore not surprise us that Davidson and Erwin concede that current theories of evolution do not explain the origin of the *de novo* body plans found in the Cambrian explosion (see Meyer 2013: 356).

IS INFORMATION A NATURAL OBJECT?

Thus far we have employed the standard and generally accepted practice which refers to "information" as a given from nature, as a "natural object". This is already clear from the fact that Wiener juxtaposes information, matter and energy – which entails that these three items belong to the same domain of (natural) objects. The implicit assumption present in this view raises the question: who naturalised information?

According to Peter Janich. the mistaken view that information belongs to the domain of natural objects should be seen as belonging to a programme according to which information is primarily viewed as an object for the natural sciences. Of course the term "naturalisation" would not make much sense if the intention is to declare something to be natural that is already natural. It should therefore rather be seen as a designation of the claim that ultimately it is solely the natural sciences that are capable to research and control information.

THE NATURALISING LEGEND AND ITS ICONS

The programme of naturalisation therefore proclaims that information is the exclusive or at least primary study object of the natural sciences. Janich calls this programme also a *Legend* with its own *icons*. The first icon of this Legend is information. Another icon of the modern Legend is *Erbinformation* (genetic information). The third icon belonging to this Legend is the *Nachrichtentecnik* (communication technologies). Information in our everyday language obtained an ambiguous meaning because it employs as starting-point distinct traditions. On the one hand it concerns the tradition of lingual communication (with the accompanying activity of informing), and on the other, procedures of transformation, coding and decoding – in which it concerns the maintenance of structures without requiring that these structures carry a specific lingual, meaningful or truth capability with them.

Janich pays attention to the possibility that the new disciplines of the 20th century, such as cybernetics and the mathematical theory of information or their application in biology, chemistry and physics, provide a basis for this ambiguity, but then points out that a perspective on the conceptual history of the term information shows that it was already divided in its Latin origins. Yet he does not want to restrict himself to the term "information" and "informing" but rather to penetrate deeper into the history of philosophy. He specifically returns to the role of form in the philosophy of Aristotle – to which we have alluded earlier. On the one hand it could be an abstract form and on the other a "formal cause" – in the spatial shape of a piece of marble brought forth by a sculptor (Janich 2006: 20-21).

LAWS: AN IMPASSE FOR PHYSICALISM

What is required in this context is to acknowledge that the status of natural laws presents a physicalist view with serious problems for if everything in the world is material and physical (matter and energy) then the nature of modal and typical laws becomes problematic. Laws condition whatever is subject to them and is shown by means of its law-conformity or lawfulness. Conforming to the measure of the law, i.e., to be law-conformative (Afrikaans: *wet-matig*), is a universal way in which modal aspects and typical entities display their subjectedness to law. Being an atom, being a molecule or being a macro-molecule is a property of what is subjected to laws, of what displays the measure of a law. But the conditions for being this or that do not coincide with what is determined and delimited by laws. The law for being a macro-molecule is not itself a macro-molecule, just as little as the conditions for being green are themselves green.

In other words, (modal and typical) physical laws are not physical by nature. Wiener therefore could have added “a law is a law” to his triplet “information, matter and energy”! The laws holding for physical entities are just as little physical in nature as the “information” assumed to be present in the genetic code. In addition, one should distinguish between the phenomenon of information and the concept information.

THE METAPHOR: INFORMATION

At this point Janich highlights an important feature of our current understanding of information, namely the metaphorical way in which we immediately speak about information. He mentions what was said by Craig Venter and Bill Clinton after the deciphering of the human genome and points out that familiar metaphors came into play. The language they used even aimed at transcending what the media conveyed – compare metaphors such as book, grammar, text or book of life. Speaking of coding, transcribing, translating, speaking and so on became indispensable means. Words from our everyday language play a key role. The English word “code” (Latin: codex) comes from “tree-trunk”, “book”, and appeared in legislative or ecclesiastical contexts (Janich 2006: 15). In general the word information in our everyday language refers to meaning (what is meant) and the validity of what is provided. Asking for a travel guide at a railway station therefore requires meaning and validity (*Bedeutung und Geltung*) (Janich 2006: 19). The phonograph (developed by Edison in 1877) achieved something completely unique and novel, namely the ability to “record” what a human says, and later on reproduce it (“play it back”). The spoken word here became objectified in a lingual artefact with its own entity-like enduring existence over time. This mechanisation of the spoken word or of communication indicates that they are transported in a technical sense, i.e. a process causally controlled by physical laws. But is does not mean that human achievements – such as speaking, calculating, seeing, thinking and writing – are taken over or performed by machines (see Janich 2006: 36).

Language is always a societal and communicational achievement of human beings. Cybernetic guiding and ruling presupposes human action, although it proceeds in a causally determined way and therefore remains, conceptually understood, within the scope of physics as a special science. The steam engine of James Watt and the modern arm-watch allow a description in purely physical terms without employing a single cognitive word derived from the sphere of human action and human argumentative intercourse (Janich 2006: 50-51).

Janich questions the above-mentioned Legend regarding the assumption that information in fact is a study-object of the natural sciences. His own view is that the term “information” is simply a metaphor within the domain of the construction of models. It is supported by three prejudices: (i) the frequent occurrence that the meaning of words is fixed through inter-human lingual communication and which then is transferred to animal, plant and non-living processes; (ii) the unwillingness to distinguish properly between the human being and nature, i.e. in respect of language and action; and

(iii) the refusal to distinguish between what is natural and what is artificial or technical. The naturalisation of information neglects the human being as original actor (Janich 2006: 65, 67; see also Janich 2000: 98-99). The cognitive metaphors applied in the description of the structural properties of reproductive phenomena are understood as a cognitive, lingual or language-similar process with the use of terms such as interpreting, coding and the translation of molecular structures within molecular biology.

The noteworthy point is that this mode of speech does not belong to the popularisation of complex (not easily to be understood) relationships for laymen, but to the special scientific language of the experts themselves. Janich discerns two weak spots in the usage of metaphors: (i) it is redundant vis-à-vis a causal description of these relationships, and (ii) it is false in respect of the choice of an inadequate metaphor (Janich 2006: 92, 97).

Within genetics "information" is understood as passing on, copying of duplicating spatially configured molecular structures. A system with a spatial configuration impresses its structure upon another system, similar to the way in which a stamped coin can pass on its cast. The same state of affairs is therefore described in two modes of description. In the first the theme is the spatial ordering of parts in molecules or chains of molecules and in the second it concerns coded information. The problem is when, through a methodological upside-down turning, the act of explaining is exchanged with what has to be explained. Nature does not explain language and science because the cultural phenomenon science in a lingual fashion explains the natural phenomena by the cultural achievements of physics and biology and the language of the communication media (see Janich 2006: 112).

LANGUAGE COMMUNICATION AND INFORMATION

The biologist who speaks about genetic information in order to take the language of molecules as the foundation for human language runs into a performative contradiction with the lingual nature of producing this theory. Language is therefore always presupposed within the cultural context in which communication takes place. And it is only on the basis of human communication that it becomes meaningful to speak about information. Interactive communication opens up the possibility to INFORM those who are involved in the act of communication. And such an act of informing depends upon the information entailed in the process of informing. Different lingual articulations can designate the same state of affairs (compare the numerical equivalence of the Roman numeral III and the Arabic numeral 3). This illustrates that the concept of information flows from the act of informing (see Janich 2006: 158-159).

The implication is that in its original sense information presupposes communication which in turn presupposes the lingual aspect of reality. Schuurman (2009: 23) provides a summary in which the rejection of a "naturalised" understanding of information as advocated by Janich is underscored:

> In connection with computers, it is customary to refer to information-processing or data-processing processes. The danger in this is that one might be led to ignore the fact that information is lingual at bottom. Language indicates and signifies

> something. And indicating and signifying are human activities, expressions of human freedom and creativity that cannot be tied up in set rules. The language which results from human activity can certainly be formalized, and formalized language can be objectified in the computer. Yet the significance of the objectified signs and symbols is human in origin; the computer's results receive their meaning through people.

In the light of the basic lingual nature of information, what is normally designated as modal laws (such as the law of energy-constancy, the law of gravity or the law of non-decreasing entropy), or type laws (such as the typical body-plans discerned in the Cambrian explosion), could be described through lingual objectification or metaphorically, as Janich argued. But then one should steer clear of a naturalisation of information and acknowledge the difference between appropriate metaphors and a causal physical explanation. Only then will it also be possible to acknowledge that communication is foundational to information.

ENDNOTES

[1] More recently Gray states: "Information theory can be viewed as simply a branch of applied probability Theory" (Gray 2011: xvii).

[2] "Information ist also eine ganz besondere Entität des Seins. Sie ist weder Materie noch ist sie Energie, beide dienen lediglich als Träger von Information. Wenn wir Materie oder Energie weitergeben, dann besitzen wir danach die entsprechende Menge an Materie oder Energie wieder. Geben wir aber Information weiter, dann geht diese bei uns nicht verloren. Information kann also nahezu beliebig vervielfaltig werden, ohne dass dazu weitere Information aufgenommen werden muss."

[3] "Es is nicht die Dezendenz, welche in der morphologie entscheidet, sondern umgekehrt: die "Morphologie hat *über* die Möglichkeit der Dezendenz zu entscheiden" (Zimmermann 1968: 49).

[4] Note that form here replaces information in the above-mentioned view of Wiener: "Information is information nor matter or energy."

[5] Cf. the Fragments of Parmenides, contained in Diels-Kranz 1959, Volume I – particularly fragments 4 and 8:3-6 where Parmenides emphasizes that in the now being is present as one coherent whole.

[6] In passing we may note that Darwin believed that if "numerous species, belonging to the same genera or families, have really started into life at once, the fact would be fatal to the theory of evolution through natural selection" for "the development by this means of a group of forms, all of which are descended from some one progenitor, must have been an extremely slow process; and the progenitors must have lived long before their modified descendants" (Darwin 1859: 309).

[7] In Shannon's sense DNA conveys information owing to the presence of long improbable arrangements of the four chemicals adenine, thymine, guanine, and cytosine (A, T, G, and C). Meyer states: "As Crick realized in formulating his sequence hypothesis, these nucleotide bases function as alphabetic or digital characters in a linear array. Since each of the four bases has an equal 1 in 4 chance of occurring at each site along the spine of the DNA molecule, biologists can calculate the probability, and thus the Shannon information, or what is technically known as the 'information-carrying capacity,' of any particular sequence *n* bases long (Meyer 2013: 166).

[8] In his own way Immanuel Kant already distinguished between these two kinds of laws, namely "pure or general natural laws" and "empirical laws of nature" (Kant 1783: 320; § 36).

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