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Emergence and advancement of basic human capacities

Original Study

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Abstract: The article departs from the Teilhardean opposition of the inside (le dedans) and the outside (le dehors), notions of reflection and self-enclosure (enroulement sur lui-même), and an experimental law of recurrence (une loi expérimentale de recurrence). The author supplements them with his own apparatus of simplex-complex transformations as an epistemic principle and a set of related practices. The article starts with quantum emergence, forging its inside and outside by an interface and an alternative way to represent it as Diracean membrane, branes of the string theory, and the eigenform. The interface instrumentality for operating the inside and outside of the quantum allows their structured totality to enact agency potential. Simplex-complex transformations allow to represent an evolutionary series of agency transformations as modules of a single model up to a developed human self. The article discusses the recurrence, enclosure, and other trickeries of emergence as well as their representation with the help of cognitive metaphors likme Ouroboros or mathematical formalisms like the Moebius strip. It proceeds to chemical catalysis and autocatalysis, further to emergence of autopoiesis, and finally to biogenesis. Forms of life internalize environmental productive factor (Umwelt) by duplication, recursion, enclosing, folding, etc. to evolve a series of codes, making up integral genetic agency and genome as its key vehicle. The article considers organismic symbiosis and respective autocatalytic recursions, addresses the emergence of signal systems and cognition, which is parallel to and duplicating neural processes. It discusses primary cognitive abilities and their further autocatalytic transformations into a range of more advanced capabilities, along with the emergence of higher levelhigher-level signal systems. Finally, it ends up by discussing anthropogenesis and stepwise emergence and advancement of human language and thought in a series of internalizations of communicative contexts (frames, typical communicative settings, mementoes and typical remembrances, etc.) into codes of the first, second, and further orders.

Keywords: Emergence, evolution, the inside (le dedans) and outside (le dehors), self-enclosure (enroulement sur lui-même), simplex-complex transformations, recursion, morphogenesis, catalysis, autocatalysis, autopoiesis, biogenesis, environmental productive factor (Umwelt), genetic agency, signal systems, genome, relaxed selection, anthropogenesis, langue, parole, language, languaging, thought, verbalization, embodiment, disembodiment.

Emergence is the key term of this article and its title. It denotes beginning *ipso sensu*. Emergence *is* the beginning of anything that comes hereafter. Thus, emergence is the moment that serves as the actual beginning or appearance of something never hitherto existing[1].

The word has a very clear inner form or conceptual metaphor. Its source is the Latin verb *ēmergō* (present infinitive *ēmergere*, perfect active *ēmersī*, supine *ēmersum*) derived from *ex* ("out") + *mergō* ("to dip, to immerse, to plunge"). The manifest vision is that of jumping out of

1 For the overview of the concept of emergence consult (Szívós 2008; Rodríguez Higuera 2016; Sherman 2017).

the water or rushing to a surface from some enfolding confinement. The word-form *ēmergentia* is plural neuter of the participle *ēmergēns*—something that appears, or rather jumps out of the eclipse, obscurity.

What is this primary "liquid" or enigmatic substance that is the locus of emergence? Leaving aside cosmological debate of singularity and Big Bang one can describe it in terms of Chaos (χάος) initially meaning "hiatus, chasm, abyss". It derives from the verb *χαίνω*—"gape, be wide open" (cf. PIE*ǵheh2n-). It is related to English yawn, to Czech *zívat* and *zet*, to Russian *зевать и зиять*.

The opposite of chaos is cosmos—κόσμος. In Greek it has a vast number of meanings from order to ornament and from honor to universe. The word derived from PIE *ḱens- having reconstructed meaning of a performative—declaring something and thus establishing order. In this context human voice and speech are creative factors of order. But this etymon is also present in the English word *beginning* as its root *gin*. The same etymon is the base for Proto-Slavic **konъ* ("beginning; end") and **čьn* ("order"), cf. the Russian words *начало* ("beginning") and *конец* ("end") or the Czech words *počátek*, *začátek* ("emergence, beginning" with the root *čát* plus alternative prefixes po- and za- meaning "after"), *začínati* ("to begin"), and *konec* ("end").

The article presents the gradually winding out story of emergence and advancement of basic human capacities. To grasp the ensuing complexity of becoming human and ever more human, one has to resort to simplexity of primeval forms, structures and phenomena themselves. In so doing, the author shall follow Pierre Teilhard de Chardin. In his seminal "Le phénomène humain" he undertakes "to discover within elements of the universe not a system of ontological and causal relations, but an experimental law of recurrence (une loi expérimentale de recurrence) expressing their successive appearance over time" (Teilhard de Chardin 1955, 17)[2].

In this article, the agency of emergence with its complementary "wings" the inside and outside, the formula of recurrence and all its aspects along with complex--simplex transformations and evolutionary modules of all kinds serve to account overall evidence of emergence and advancement of basic human capacities from their primal and elementary appearances to the most sophisticated accomplishments of human cognition[3]. In other words, initial setups are linked with the outcomes of evolution and respective manifestations of human capacities—λόγος, word, reason, intellect, scientific method etc. Respective variability of phenomena and their time-space dimensions range between the quantum and the cosmos from 10–20 cm (subatomic quanta) up to 1025 cm (supragalactic) (Rees 1999, 8). They also diverge along the mirror inversion of energy-matter and information dimensions, as well as along the parameters of complexity and simplexity.

Such an ambitious goal and scope of research corresponds to the purpose of "Le phénomène humain" as it is explained by its author: "Reduced to its ultimate essence, the substance of these long pages can be summed up in this simple affirmation: that if the universe, regarded sidereally (sidéralement), is in process of spatial expansion (from the infinitesimal to the immense), in the same way and still more clearly it presents itself to us, physicochemically, as in process of organic involution upon itself[4] (from the extremely simple to the extremely complex)—and, moreover this particular involution 'of complexity' (cet enroulement particulier 'de complexité') is experimentally bound up with a correlative increase in interiorisation, that is to say in the psyche or consciousness" (Teilhard de Chardin 1955, 304).

With all his insightful breakthroughs of the human phenomenon visual (theoretical) interpretation, Teilhard de Chardin failed to clarify a few key questions. Or probably he simply did not bother since they could distract him from disclosing the overall logic of human evolution.

The first question is—the inside[5] (le dedans) and the outside (le dehors) of what? Teilhard de Chardin

2 Here and further in the text of the article, references follow pagination of the original French edition of 1955. The English quotations of "The human phenomenon" (I prefer this translation of the title rather than "The phenomenon of man") refer to its electronic edition translation with no pagination therein (Teilhard de Chardin 1959). Whenever necessary, original French wording is added in brackets.

3 In the INION Center for Advanced Methods well back in 2013 we undertook critical re-evaluation of reliable distinction of quantitative and qualitative methods. Soon we replaced this crude binary opposition with a triad of complementary methodological complexes or organons. We linked each to basic cognitive abilities. The first one was an aptitude to recognize intensity of sensual impressions, to range and thus 'measure' them. The second ability was pattern recognition allowing to deal with images, forms, and structures. The third capacity was ascription of some value to sensual signals and images which allowed to operate with meanings. Respective organons are metretics with elaborate calculus and statistics, morphetics with morphological and structural analysis and semiotics with studies of communication and interactions of all kind of agencies. Linkages between the three organons and cognitive primitives were confirmed by reciprocal simplification or *purification* of the sophisticated methods down to basic cognitive faculties, and reciprocally by *saturation* of cognitive primitives up to complex intellectual skills and scientific techniques. The ranges of respective modules within each continuum cogently let us interpret their sequences as transformations between two extremes of utter simplexity and complexity.

4 Another way to translate the expression "in process of organic involution upon itself" may be "in an organic self-enclosing into itself" (en voie d'enroulement organique sur lui-même).

5 The English translation of 1959 renders *le dedans* and *le dehors* as *the Within* and the *Without*. My terminological

consistently uses the definite article implying that the words are not just occasionally and contextually substantivized words but regular and basic terms reflecting systemic analytic entities. Throughout the book, Teilhard de Chardin explores the inside and outside of things or any objects of his consideration from atoms to the noosphere of Earth.

How do the inside and outside merge into common totality? Or they primordially constitute "things"? What else comprises this totality?

How do the inside and the outside relate to each other? In Teilhardean interpretation, they seem to be just two aspects of a single phenomenon providing it with two different energies—radial and tangential. Tangential energy is related to physical energy. Radial energy in some way accounts for increasing complexity and consciousness in evolution (Morowitz, Schmitz-Moormann, Salmon 2005). Energies are also linked to contrasting entropies—the Bolzmanian one and the Shannonian one. (Salmon 2003).

It is fairly typical to interpret the pair of the inside and outside as further refined sets of juxtaposed spiritual and material, mind and body etc. (Reis 2014), but actually their interrelations appear far more complex, and controversial. If the inside and the outside are complementary, then what is common and what is different? What do the differences account for? How are they interrelated? What does actually happen with embodiment and disembodiment? And, eventually, what plays the role of a link between the inside and outside and acts as a mediator? Pierre Teilhard de Chardin has not explored those questions. The article in this or that way touches upon them and suggests operational patterns, feasible models, or at least respective conjectures. In various ways such instrumentalities and devices serve to make Teilhardean "experimental law of recurrence" and work. Thus, they are essential to understanding both emergence and evolution.

For the purposes of the article, the questions on ontological and cognitive statuses of the outside and the inside are equally crucial. How do they exist? What is the distinction of the inside and the outside for each or us, humans, subjectively? How can one represent it objectively, e.g. in mathematical abstract models?

Those questions set up the agenda of the article and shape its structure.

MEMBRANES, BRANES, EIGENFORMS AND INTERFACES OF THE INSIDE (LE DEDANS) AND THE OUTSIDE (LE DEHORS).

A promising way to explore the issue of complementarity and interactions of the inside and the outside, as well as their plausible structural-functional relations, is to address the epistemic models of their interfacing. A cognitive metaphor of membrane is probably the most revealing of all available intellectual devices. Our skin and other similar tissues are something that separates and connects external and internal aspects of our very existence. Respective orientational metaphors (Lakoff, Johnson 1980) are fundamental to human thinking since they directly use ontic relations at large—those of the human phenomenon specifically.

Furthermore, it is not just our thinking but phenomena themselves. Jessper Hoffmeyer insightfully clarifies: "Life is built on a fundamental asymmetry, but this is not an asymmetry between organism and environment. Instead it is an asymmetry produced by any closed membrane (e.g. the skin) which separates the world into two equally excluded parts: an internal part and an external part. The membranes of living systems—at whatever level, i.e. whether they encircle sub-cellular organelles, cells, tissues, organs, or organisms—are in fact best described as interfaces facilitating a highly regulated exchange of signs between interiors and exteriors" (Hoffmeyer 1998, 35).

It is fully justified to consider the inner and outer aspects of things to be separated and simultaneously linked by a membrane of a kind that belongs neither to inner nor outer, but still remains inseparable from them. Membrane is a very appropriate term in this context. It derives from Latin *membrāna* which means just that—the skin of a body. The vague image of "skin" can be made concrete and operational with the help of the Dirac membrane. It is a minimal abstract mode to mathematically represent structural conditions for the very existence of electron or any other particle or a discrete physical entity. Paul Dirac applied an ingenious way to reveal the action principle for the membrane. He suggested that closed membranes work as an obvious split of space into the interior and the exterior; one can apply curvilinear coordinates x in spacetime and a function f(x) such that f(x) = 0 defines a membrane while f(x) > 0 and f(x) < 0 designate spaces outside or inside the membrane respectively (Dirac 1962).

Such fruitful brainchild of Dirac found its way into string theories since the border of the 60s and 70s. In over two decades, elaboration on higher-dimension extended objects led to consolidation of the supersymmetric theory (Hughes et al. 1986; Bergshoeff, Sezgin, Townsend 1987)—the second publication with a direct reference to Dirac (Bergshoeff, Sezgin, Townsend 1987, 2). In their turn. Duff with colleagues applied the name *2-branes* to "extended objects of one time and two space dimensions" (Duff et al. 1988, 515) and also coined the term and *p-brane*. They were adapted compressions of Diracean *membrane* or later *supermembranes*.

Branes represent a point particle to higher dimensions in string theory and related theories in physics.

preference would be *the Inside* and *the Outside*. Throughout the article I consistently use the terms *the inside* and *the outside* with the definite article and lowercase letters and occasionally may use words *internal* and *external* in all other contexts (adverbial, adjectival, or loose).

A point particle can be regarded as a brane of dimension zero at the same time as a string can be considered as a brane of dimension one. The term *brane* usually refers to a two-dimensional brane with maximal resemblance to a membrane. It is also possible to consider higher-dimensional branes, e.g. in the 11-dimensional variety of M-theory. The very name of the M-theory comes from the word *membrane*.

M-theory integrated various string theories by claiming that strings are really one-dimensional slices of a two-dimensional membrane pulsating in 11-dimensional spacetime. Higher-dimensional objects are far higher mathematical abstractions than a point in Newtonian physics is. Their representation may be upheld by the tools of complex geometry representing geometric curves in algebraic terms (Yau, Nadis 2010, 180—1). Alternatively, symplectic geometry studies spaces with the so-called symplectic form operational to compute area in two-dimensional models (Zaslow 2008, 531). With the homological mirror symmetry conjecture of Maxim Kontsevich (Kontsevich 1995) such complementarity provides a helpful bridge between two branches of geometry—complex and symplectic (Yau, Nadis 2010, 181). Methodologically, this corresponds to complex-simplex transformations developed by our team in the INION Center for Advanced Methods (Ilyin 2020) and constitutes one of the cornerstones of our current RSF project[6].

Important clarification should be made on the 11-dimensional spacetime of M-theory. While all extra dimensions above the three Euclidean ones and the additional time dimension of Einstein are considered spacelike in standard M-theory, it is more likely that they are just timelike—as suggested by Bernard Carr (2015). Closed timelike dimensions are interesting because they violate old-fashioned causality patterns. Instead, one can associate them with a hierarchy of spatial timeless states, i.e. there be no distinction between past/present/future on smaller timescales less than the spatial "present" (Bernard Carr—personal communication). Or, in my view, temporal (4th to 11th) dimensions represent multidimensionality of evolutionary orders. In other words, they are mathematical formalizations of the anthropic principle and Deaconian logic of ententionality and intentionality.

Another relevant mathematical formalism is that of the so-called *eigenform*—a fixed point for a transformation, including transformation of inside into outside and back: "Heinz von Foerster (1976) introduced the eigenform and eigenbehavior concepts by considering *an agent that both observes and acts on a surrounding world*: an eigenform is an observation that remains invariant, in the limit of long interaction time, under some class of behaviors, while an eigenbehavior is an action that, in the same limit, leaves some eigenform invariant. These concepts naturally suggest an abstract picture in which the eigenbehavior continually reproduces the eigenform, independently of any other features or dynamics of the world. In this picture, eigenform and eigenbehavior compose a single reflexive system; all other aspects of the world can be neglected. Louis Kauffman has shown, conversely, that all such reflexive systems have eigenforms and eigenbehaviors as invariants" (Fields et al. 2017, 265).

According to Louis Kauffman eigenform is essentially instrumental for reflexivity and self-reflection: "The Universe is constructed in such a way that it can refer to itself […] the universe can pretend that it is two and then let itself refer to the two, and find that it has in the process referred only to the one, that is, itself." (Kauffman 2009, 134). In other words, it plays a role similar to that of membrane when it separates the inside and outside by doubling reference (see the next section on quantum and Albert automata). Another important consequence of the reference function of eigenform is that it also doubles substance (matter) itself producing its alternative and complementary forms or modes of existence—energy and information modes. This allows Chris Fields with co-authors to interpret it as an important way of overcoming metaphisycal dualism of mind and body: "This formulation makes explicit an important point: that there is no difference in substance, and hence no metaphysical dualism, between agent and environment" (Fields et al. 2017, 265).

Louis Kauffman explains the potential of the eigenform formalism in consecutive steps. His first claim links it with transformation: "« 1 » An eigenform is a fixed point for a transformation. In this context an arbitrary transformation is allowed. Transformation means change and when we speak of a transformation, we mean that it is possible for observers to register a change and to begin to describe how that change takes place" (Kauffman 2017, 246). Then he reinterprets mathematical formalism in terms of semiotic pragmatism or agency: "« 3 » Before using any mathematical formalism, consider the following sentence: 'I am the one who says I."

Kaufffman further elaborates first person perspective: "« 4 » This use of the word 'I' is an example of a linguistic eigenform. The word 'I' refers to a person, and to the person who is speaking. In this way, I can refer to myself when I say 'I say that eigenforms are fixed points.' But in the above sentence 'I' is itself a fixed point of the phrase 'the one who says." (ibid.). This allows him to return to mathematical formalization and strict equation: "« 5 » We can rewrite the sentence as 'I am identical with the one who says I.' « 6 » And this can become the symbolic 'I = the one who says I.' and in that way 'I' is the fixed point or solution to the equation 'X = [the one who says] X.'; 'X = F X." (ibid.).

6 "Knowledge transfer and convergence of methodological practices: cases of interdisciplinary integration of political, biological and linguistic research" (2017—2021) supported by the Russian Science Foundation (grant project number: 17-18-01536).

QUANTUM

At a very early stage of our studies of transdisciplinary methodologies in 2014, I learnt an important insight from Artem Yurov, a mathematician from Immanuel Kant Baltic Federal University in Kaliningrad. When I told him about our search for primitives of measuring (potentially calculation), pattern recognition (potentially comparative studies and morphologies) and evaluation (potentially semiotics), he immediately suggested that I should consider so-called Albert automation (Albert 1983; Albert 1987). In Yurov's view, this class of quantum automata is able to self-center its operations strictly directing autoreferential ones inside and referential ones outside. In his view this demonstrates a very distant and rudimentary semblance of "subjective experience" (Yurov 2003; Yurov 2017). He assumes that such automata are capable of generating Gödel's propositions, making incompatible alternatives actual (cf. further elaboration Wolf 2018). I would even suggest that emergent quantum duality[7] is pregnant with nascent space-time distinction and, eventually, with the Teilhardean concomitance of the inside (le dedans) and the outside (le dehors). Ensuing the opposition of spiritual (cf. Yurov's analogies to subjective experience) and material distinctly corresponds to well-known juxtaposition of entropy and negentropy or rather two entropies—the Bolzmann and Shannon ones. In our observable universe with its anthropic principle[8] the divergence of the two entropies matches overall cosmological trends and may boost phenomena of emergence and evolution above and beyond quantum levels. Furthermore, divergence recursively infers convergence. Complementary mutual reference expounds into circularity which works in fact as the regulatory principle of the ensuing evolutionary transactions.

Respective complex-simplex transformations allow to establish a range of modules of emergence all the way from quantization of discrete amounts of matter and energy through alternating headway of information-energy setups up to elaboration of subtle human cognitive capacities. With all that, ultimate quantal simplexity as well as eventual cognitive complexity would not stand on their own but would mutually infer each other. One may call such an operational trick implicit cogitation inference. It may be evident that elemental phenomena like subatomic quanta emerged long before humans or any kind of cogitation procedures. But to understand, interpret, or even to acknowledge their very existence, certain cognitive conventions are absolutely indispensable. This is exactly the case of Albert automation or any other kind of automation. After all, this term explicitly denotes the idea of something moving and even 'minding' on one's own as it is expressed by the Greek adjective *αὐτόμᾰτος*. Its component, prefix *αὐτο-* ("self", literally "against the other"), derives from PIE **h₂ew* ('again', 'against') and **to-* ('that'); the root *μᾰτ-* descends from PIE **mn̥tós* ('repeating in mind'), which in turn originates from **men-* ('to think, to mind'). The cognates include not only Greek *μένος*, Latin *mens*, and English *mind*, but also Russian *мнить* ('to mind, to conjecture') and *мнение* ('opinion') and an archaic Czech verb *mnít* ('think'), which persists in words *domnění* ('presumption') and *domněnka* ('conjecture').

The key moment is construction ("emergence") of a device "with mechanisms for the input and output of information" or with an ability to discriminate the inside (le dedans) and the outside (le dehors)[9]. Far more important is the fact that such a 'self-minding' device distinctly displays cognitive abilities and other typically human qualities: "We could in principle, after all, construct an automaton (*my parenthesis—M.I.*: a macroscopic automaton, one that *walks around*, one that *speaks English*, one to which it would seem natural *to assign mental states*) wherein information is stored and processed within microscopic physical systems, systems which are necessarily quantum mechanical" (Albert 1987, 584).

Elementary emergence of minimal or simplex matter-energy quanta can make sense or happen only if they are shaped or structured as complex automotive, self-reflexive, or even cognitive entities. Simplexity can be understood and defined only as an absence or deficit of complexity. And in a similar mirror-like way complexity infers a lack or shortage of simplexity.

This counterpoint of simplexity and complexity in the case of quantum self-enclosure is beautifully interpreted by Pierre Teilhard de Chardin. He claims that the primary quant-making (he calls it *atomicity—l'atomisme*) "is a common property of the 'Within' and 'Without' of things" (Teilhard de Chardin 1955, 47). His next claim is that

7 The complementarity principle upholds that twin properties of quantum objects cannot be observed or measured simultaneously, e.g. dualities of wave-particle duality, momentum-position etc.

8 Anthropic principle embraces over two dozen intermingling claims that essential aspects of the observable universe (its dimensions, constants etc.) are fine-tuned for life to emerge there. Those claims may look circular definitions since they assume a prior endorsement of the term being defined namely that of human observation of the universe. Still their very circularity is nothing but the vehicles of emergence, automation / autopoiesis and eventually cosmological evolution.

9 "Suppose that we construct an automaton with mechanisms for the input and output of information, with a variety of instruments for measuring a variety of physical observables, with an inside program that included a set of rules for predicting the behaviour of some simple physical systems (including itself), given their initial conditions, and which itself operates in accordance with the laws of quantum mechanics" (Albert 1983, 249). "Suppose, then, that an automaton is constructed with mechanisms for the input and output of information, and with instruments for measuring physical observables…" (Albert 1987, 578).

"spiritual perfection (or 'conscious centreity'—*«centréité» consciente*) and material synthesis (or complexity) are but the two aspects or connected parts of one and the same phenomenon" (Teilhard de Chardin 1955, 48). This would allow to establish "a qualitative law of development that from sphere to sphere should be capable of explaining, first of all the invisibility, then the appearance, and then the gradual dominance of the 'within' in comparison to the 'without' of things" (Teilhard de Chardin 1955, 48).

Teilhard insists that that the complementarity of the inside ('within') and the outside ('without') of things is expressly evolutionary: "This law reveals itself once the universe is thought of as passing from State A, characterized by a very large number of very simple material elements (that is to say, with a very poor 'within'), to a State B defined by a smaller number of very complex groupings (that is to say, with a much richer 'within')" (Teilhard de Chardin 1955, 48—49). And he concludes very gracefully: "Refracted rearwards along the course of evolution, consciousness displays itself qualitatively as a spectrum of shifting shades (un spectre de nuances variables) whose lower terms are lost in the night" (Teilhard de Chardin 1955, 47).

This rearward retrospection—and this is exactly what David Albert and other quantum physicists do—has its frontward prospection or foresight, "[b]ut this quantum only takes on its full significance when we try to define it with regard to a concrete natural movement—that is to say, in duration (dans la Durée)" (34).

The whole range of transformations or jumps over from automotion through automation, autocatalysis, autopoiesis to cognition and self-cognition end up with the maxim 'know thyself', *γνῶθι σεαυτόν*.

HOW IT FEELS TO BE AN AGENCY?

Agency emerges as a response to the need to separate shapeless inner and outer aspects of phenomena and to regulate the emergent inside and outside if one uses the conceptual system of 'incomplete nature' (Deacon 2011)—the most developed one to the date. In its most advanced manifestations, there are conscious human selves and organized social orders. It is a very long and conspicuous way from initial division of internal and external to elaborate enterprise of cutting-edge science. Some key moments would show up in this review. But at this juncture, our complex-simplex transformations would transform themselves into complex-simplex jump, a radical leap from the initial moment to the current one. Methodologically it is fallacious, of course. One has to proceed consistently, not missing a single step. But to make the overall logic obvious and more visual, the contrast of crude and sophisticated would work better.

A membrane is something primeval that transforms a portion of what one would later interpret as matter and energy into a quantum. And it simultaneously creates what one would later call information or fluid flows between the inside and outside of the quantum as well as between a total quantum and its broader outside. If I dreamt of asking the main question of philosophy, *die Grundfrage* (and it is not my intention since I shun all ultimate conjectures, basic question, or final solutions), I would claim that in the evolving universe it is a membrane that is primary—not energy or information in scientific terms and matter or spirit in philosophic terms.

You can operationalize membrane as branes and eigenforms to interpret them as alternative displays of operational interface of the inside the outside. Such an interface functions as the active self-like mediator that regulates relations between the inside and the outside. It is rational to distinguish this mediator from specific notions and terms like *membrane*, *brane*, *eye*[10], agens, agent, actor, etc. devised by various disciplines and schools for their specific needs and contexts. Agency may be the appropriate term for it is used in broad contexts from biosemiotics to human interactions, though it does sound applicable to either quantum or cosmological scopes.

It should not be treated naturalistically, but analytically and logically. Thus, paradoxically our bodies that we use as a resource for conceptualizations of all kinds (Lakoff, Johnson 1980) represent the outside of our thinking, cf. also Cartesian distinction of the two 'substances'. Our bodies are not something 'within' but rather 'without' if their exclusive material properties are considered. Likewise, our thoughts or emotions albeit embodied are essentially virtual information entities that belong to the domain of the inside along with disembodied cognition and communication. None of the domains can function on its own but only in conjunction with each other in reciprocal metamorphoses of embodiment/disembodiment and information/deformation.

This uneasy opposition of body and soul was discussed by René Descartes. He has undertaken a thought experiment very similar to our 'purifications' within simplex-complex transformations (Ilyin 2020; Fomin 2020). He tried to discard everything excessive, redundant, or just unnecessary and alien to operations of his mind. All the bodily properties were easily removed. The result of the thought experiment is the reduction of the multi-component Self from flesh and blood step by step up to the final limit—the essence of the mind itself without bodily extension. Within the conventional scholastic tradition deeply entrenched in mentality of Descartes, he interpreted his thought experiment with his whole and complete Self (totum me) as division into two different substances: the extended, but not thinking, and the thinking, but not extended.

In his objections, Thomas Hobbes quite reasonably drew the attention of the author of Reflections to the fact that the interpretation of the results of his thought

10 I specifically refer here to Wittgenstein's notion of *Auge* introduced in "*Tractatus Logico-Philosophicus*" where he discusses relations between the world and the metaphysical subject who is outside of the world (5.632—5.633).

experiment in scholastic terms of substance turns into an involuntary swindle: "What therefore is there that can be distinguished (distinguatur) from my thinking (a mea cogitatione)? What can be considered separate from myself (a me ipso separatum)? Perhaps someone will answer this: I myself, who think (ipse ego qui cogito), am to be distinguished from my thinking; but my thinking is not separate (separatam) from me, but distinct (dīversam) from me, just as dancing (saltātiō) is distinguished from the dancer (saltante), as was pointed out above. But as long M. Descartes would have claimed (ostenderit) that the one who understands (intelligit) and the understanding (intellectum) are one and the same, we shall fall back into the Scholastic mode of talking (modus loquendi Scholasticum): 'the understanding understands', 'the sight sees', 'the will wills', and, to use an exact analogy, 'the walk or at least the faculty of walking walks'. But all these expressions are obscure and incongruous, and most unworthy of M. Descartes's usual clarity (perspectuitate)" (Cartesius 1641, 242—243).

Strenuous Descartes—such is his integral self with all his passions—simply could not agree with Hobbes' acute remark. And he immediately finds ways to deflect Hobbes' objection: "I do not deny that I—the thinker—differ from my thinking, as a thing from a mode (rem a modo). Yet when I ask 'Is there any of them that can be distinguished from my thinking (quid ergo est quod à mea cogitatione distinguatur)?', I am talking about the various modes of thinking just listed, and not about my substance. So, when I add 'Is there any of them that can be said to be separate from me (quid quod a me ipso deparatum dici possit)?', I mean only that all these modes of thinking are present in me (significo tantum illos omnes cogitandi modos mihi enesse); and I cannot see what could be portrayed dubious or obscure" (Cartesius 1641, 243).

It is a pity that Descartes would not explore Hobbesian objection profoundly. He was fully equipped to do that. In the 'Principles of Philosophy' (part 1, paragraphs 60—64 ff.), he postulates discrimination to be threefold: real, modal, and mental[11]. The substances are perceived really differently on the basis of real or 'substantial' discrimination. Modal distinction is twofold: one of them is the distinction between the mode in the proper sense of the word and the substance, of which it is a mode; the second is the distinction between two modes of the same substance. Finally, the mental distinction is "held between a substance and one of its attributes, without which it cannot be comprehended, as well as between two such attributes of the same substance" (page 62). In paragraph 63, Descartes explains that "thinking and extension can be clearly perceived as forming the nature of mind and body". Finally, in paragraph 64, Descartes shows that it is possible to clearly cognize extension and thinking, taking them "for the modes or attributes of those substances". Thus, Descartes actually discriminated modes (forms) and attributes (meanings) and habitually postulated them to different substances. Why not to imply that the modes and attributes relate to a single substance? Then the scholastic and inflexible dualism of mind—body would be replaced by a subtler adaptable model.

Descartes was on the threshold of such a remarkable breakthrough. He used the terms *res cogitans* and *res extensa*, which implied that adjectives denoted modes of attributes while the noun referred to the same substance. But he followed the scholastic distinction of two different substances as well as ordinary speech practices: "However, among logicians, and among all ordinary people, it is customary to talk about two different substances (substantias alias)—spiritual (spirituales) and bodily (corporeas)" (Cartesius 1641, 240). It would had been far more valuable to recognize one single substance as the primal basis and source of both matter-energy and information. It could be more fortunate to call this primal base not a substance but a substrate (Deacon 2011 passim). Naturally, Terrence Deacon discusses mainly physical, molecular, or material substrates, but the Big Bang and string theories allow far more fundamental substrate of initial singularity.

Singularity with no spacetime or other particulars was an enigmatic state from which our universe 'dived out', or emerged, about 13,799 billion years ago with the so-called Big Bang. The universe expanded and 'cooled down' in accordance with the second law of thermodynamics producing space with mass and energy and ever more numerous particles and fields. Parallel to that, the universe shaped into galaxies and quanta producing time, organization, and information. Quanta played a crucial role 'pulsating' with indeterminacy and complementarities, wherefrom emerged or 'dived out' separation of the inside and the outside with mediating membrane. The membrane was instrumentality of both the inside and the outside and their integral total. Thus, already on the quantum level, a simplex scheme or module of agency shapes itself: instrumental membrane mediating the inside and the outside entangled into the enclosing total. This simplest module further transformed into a series of ever more complex modifications of agency. To date, it is fulfilled with a module of free self-sustaining actor who is emblematized in literature by Robinson and Faust and in science by Descartes himself and Newton.

RECURRENCE, ENCLOSURE, AND OTHER INSTRUMENTALITIES OF EMERGENCE

Ways of making phenomena emerge and evolve are essentially simple. One can boil them down to a very few key instrumental crafts or 'trickeries'. Three of those instrumentalities are the very elementary ones: recurrence (moving back in a kind of U-turn), enclosure (closing the

11 Cartesian triple distinction clearly corresponds to our own of organons: calculative or metretic matches real, pattern recognizing and morphological corresponds to modal, and sensemaking or semiotic pairs mental.

passage back), and transfer (merging the initial and concluding moments). Three more are a bit knottier variation of the same principles: replication (series of returns), convergence (multiple enclosures into a complexity), and autopoiesis (consistent change into a new envisioned state).

All the instrumentalities mentioned are closely interrelated. After all, they all lean upon the same cognitive foundation and take maximum advantage of it. It is possible to identify a single set of orientational cognitive metaphors (Lakoff, Johnson 1980) capitalizing on an image of a circle or circular movement. Such appearances range from pictorial and emblematic to visually plain and schematic.

A vivid symbolic embodiment of the metaphor is the persona of Ouraboros (Οὐροβόρος) or a serpent biting its own tail[12]. Such an iconic epitome has a momentous symbolic potential in many cultures from Ancient Egyptian (serpent-god *Mehen*) and Old Norse (*Jörmungandr*) to Vedic (*Shakti*'s transfiguration, symbolizing the cycle of *samsara*) and Biblical (*Leviathan*). The same image is widespread in Gnostic, Hermetic, and Alchemic traditions. It is handled in modern psychology (cf. Carl Jung and others) and even physics (Rees 1999, 8 ff).

Ouroboros imagery had been highly instrumental in establishment of the benzene ring structure. August Kekulé remembered the history of its discovery along with creation of the theory of chemical structure at a special session on March 11th, 1890, celebrating the twenty-fifth anniversary of his first benzene paper (Kekulé 1865). Both breakthroughs in the development of modern chemistry were foresighted in Kekulé's dreams: "During my stay in London I lived for a long time in Clapham road near the Common. But I often spent the evenings with my friend Hugo Müller in Islington… On a beautiful summer day, I once again took the last bus through the desolate streets of the otherwise busy world city; 'outside', on the roof of the bus, as usual. I sank into dreams. The atoms were fiddling before my eyes. I had always seen them in motion, no beings at all, but I had never been able to hear the nature of their movement. At the moment I saw how many times two smaller ones joined together into pairs; how larger ones embraced two, still larger ones held three and even four of the little ones, and how everything turned in whirling round… The call of the conductor, 'Clapham road', roused me from my reveries, but I spent a part of the night at least in putting on paper sketches of those dreams. This is how the structural theory came about" (Schultz 1890, 1306).

Right after that, Kekulé remembered another dream: "It was similar with the benzene theory. During my stay in Gent in Belgium (the actual event happened probably early on 1862—*M.I.*), I lived in elegant bachelor rooms in the main street. My study, however, lay on a narrow side street and had no light during the day. For the chemist who spends daylight hours in the laboratory, this was not a night duty. Then I sat to work on my textbook. But the job would not proceed. My mind turned to other things. I moved the chair towards the fireplace and sank into a semi-sleep. Again the atoms fidgeted before my eyes. Smaller groups kept modestly in the background this time. My mental eye, sharpened by repeated faces of a similar kind, now distinguished larger formations of manifold design. Long rows, often brought together more densely; everything in motion, winding and twisting like a snake. And behold, what was that? One of the snakes grabbed his own tail (erfasste den eigenen Schwanz) and mockingly swirled the structure before my eyes (höhnisch wirbelte das Gebilde vor meinen Augen). Like a flash of steel, I awoke. This time, too, I spent the rest of the night working out the consequences of the hypothesis" (ibidem).

The imagery used imply not just a single ring-making but movements of 'larger formations of manifold design' (größere Gebilde von mannigfacher Gestaltung). 'Long rows' would move, curve, wind and twist 'like a snake'. Chains of atoms swirl in diverse proportions and features. The mocking Ouroboros would shape not into a regular circle but rather helix into a spiral curve. Its closure would produce nothing but the Moebius loop. Thus, a graphic or even picturesque appearance would reshape or translate into a far more schematic outline. The 'cyclic' cognitive scheme is completed by paradoxical configuration of Moebius loop, or rather, band. It is a one side surface with only one boundary curve.

The Moebius band can be defined as the basic non-orientable surface. This unique delineation has quite a few peculiar qualities. A line hauled along the edge envelops into a complete circle at a point right across from the starting point. When resumed and extended, the line reverts to its own starting point. Besides, it doubles the length of the initial loop. Finally, the singular endless curve traverses the entire boundary. All those characteristics display a range of structuration options that are fairly instrumental and can be employed to transpire into emergent shapes and figures.

Coming back to the three elementary (or simplex) instrumentalities, one is to tackle recurrence or a movement backwards in a kind of U-turn. It is nothing but a master principle of any emergence and all the evolution. The idea can be expressed by a broad range of terms: repetition, reoccurrence, reversion, revolution, reiteration, recycling, etc. Even words like *loop* or *circle* may be treated as synonymous since they are based on the selfsame metaphor of a roundabout movement.

Recursive processes shape themselves with a series of rules as a new reproduction of the source state albeit with variations and alterations—algorithmically contingent or encoded as the case may be. This basic principle remains the same, but procedures, routes, and outcomes vary all the way through. Eventually, recursion appears problematic, since requisites and responses may be at variance. Something distinctly 'new' and even innovative is expected but at the same time it should remain 'old', or

12 From Greek *oúrā̃* ("tail") cf. PIE **h₁ers-* ("backside) and *-βόρος* ("-devouring") cf. PIE **gʷerh₃-*.

essentially basic, initial. Furthermore, the consistent overall circular train comes out different in each venture. With all the preeminence of the circular movement, its shapes, curves, modes, and outcomes are exceedingly diverse and numerous. What makes them all different but actually still the same are instrumentalities and expedients at work. Let me repeat, they are three elemental devices—recurrence (moving back), enclosure (closing the track), and transfer (merging the initial and concluding moments) and their composite variations—replication (series of returns), convergence (multiple enclosures into a complexity), and autopoiesis (consistent transition into a projected state).

FROM CATALYSIS TO AUTOCATALYSIS

At the Age of Revolutions Elizabeth Fulhame published a book (Fulhame 1794) and thus made a true breakthrough in chemistry and—one can duly claim—in human sciences at large. She empirically exhibited and tested a phenomenon that was later called catalysis (Davenport, Ireland 1989; Laidler, Cornish-Bowden 1997; Palmer 2008)[13]. Her discovery not only changed our everyday lives but advanced our ways of thinking about the modes and patterns of transformations. She demonstrated that even simple chemical reactions may require more than one step (Cornish-Bowden 2013, 31). Furthermore, those stage-by-stage reactions would go only in the presence of something that works as a productive factor enhancing or even boosting respective reactions.

Elizabeth Fulhame experimented with a number of chemical reactions by which metal salts could be reduced to pure metals. It turned out that ever present water or light may become productive factors entering into reactions "in a cyclic fashion, consumed in one step of reaction, and regenerated in a later one" (Cornish-Bowden 2013, 32) retaining its environmental quality and status. In other words, it is the environment itself that instigates a chemical reaction.

Instigated or catalyzed processes should not be limited only to chemical reactions. They may extend to other realms and domains of interaction maintaining the logic and basic structural properties similar to catalysis. Thus, Bob Hodge has pointedly remarked that semiosis is analogous to catalysis[14]. In this case of human communication, the 'catalyst' would be a context or its decontextualized copies in the forms of codes and language systems. They join in and facilitate an interaction of a signifier and signified (in Saussurean terms) or interactions of representamen, object, and interpretant (in Peircean terms). But those interrelations as well as reactions involving assorted chemical elements would not go unless supported and even directed by the catalyzing contexts or environments—or their autocatalytic substitutes in much more complex and advanced situation.

Summing up some crucial outcomes of my research within the ongoing RSF project I would demonstrate that this principle and related tricks and procedures in a range of their transformations reveal holomorphic modules of productive factors (both external and self-inducted internal ones) that enable and advance biological life, promote basic capacities of organisms and human beings, maintain language and thought.

Elizabeth Fulhame was initially motivated by an ambition to find "the possibility of making cloths of gold, silver, and other metals" (Fulhame 1810, IX). She tested reduction of metallic salts of gold, silver, copper, and tin with a variety of reducing agents like hydrogen, phosphorus, charcoal, light, and a range of sulfides. She probed a number of salt states from dry to water or alcohol solution. Finally, she discovered that many chemical reactions would not go unless they are arranged stepwise with an environment joining in at one stage and recursively leaving at another remaining an enduring external factor.

In a broader context, the principle of unbinding—rebinding would account to, explain, and provide structuration models for any singular instance of emergence and of its successive serial advancement. The structural logic of catalysis displays a pattern of a two-way transfer through phasedown and induction of simplexity (this is the key step of 'unbinding') with a recursive U-turn to a conceptually implied 'rebinding' by discharging novel prospects and successive upgrade of complexity. By way of example, catalytic boosting of chemical reactions resembles enhancement of evolvability (Houle 1992; Wagner, Altenberg 1996; Kirschner, Gerhart 1998) in living systems by relaxed selection with a phase of relative degeneration prior to functional upgrading. In the same way, a similar shuttle-like pattern may effectively work for social, cultural, and linguistic advancement (Deacon 2010). In other words, structural logic of recursive unbinding—rebinding is a kind of a master key to unlock a few very simple tricks and procedures that turn a 'neutral' symmetrical and non-directional transfer into a 'charged' asymmetrical growth having its own course and eventually 'meaning'.

Based on recurrence, catalytic boosting may become an evolving entity itself as long as it provides conditions of its own cyclic renewal. When it happens, a catalytic reaction starts to reproduce itself if one of its reaction products appears to be a catalyst for the same reaction. Catalysts may couple or even multiply in a related set

13 The term *catalysis* (*katalys* from Greek *κᾰτᾰ́*—down and *λῡ́ω*—I loose, untie with an overall meaning of "unbinding, releasing") along with *polymer*, *isomer*, *protein*, *allotrop* etc. was coined by the "Father of Swedish chemistry" Jöns Jacob Berzelius in 1835 (Berzelius 1835, 245) to describe reactions that are accelerated by substances that remain unchanged after the reaction.

14 I am grateful to Bob Hodge who draw my attention to Elizabeth Fulhame and the significance of her discovery for semiotics and complexity theory. He indicated a parallel between a catalysis and a semiosis during his talks in Moscow in November 2019.

of reactions which makes them an autocatalytic set. As a result, those collectively supportive reactions produce an ample number of catalysts for the other reactions and thus the entire set of chemical reactions becomes self-sustainable. Eventually, an autocatalytic set gains an evolutionary advantage over reactions that erratically obtain a catalyst from the outside environment (Jain, Krishna 1998; Hordijk, Steel 2018).

BIOGENESIS

The word biogenesis sounds as if it implies only one and momentary event like the one described in the *Book of Genesis*. But its actual 'beginning' is blurred and the very 'genesis' continues as an ongoing process until now. Still at some juncture, probably around 4 billion years ago, chemical evolution reached the state when the overlapping outermost layers of Earth constituting its membrane (its lithosphere, hydrosphere, atmosphere) were complemented with a kind of primordial pedosphere. Dynamic interactions within this skin of the Earth made it the mediator of chemical and biogeochemical flux into and out of these respective systems saturated with gaseous, mineral, fluid, and biologic components. The proto-pedosphere comprised thin scraps and slices of the products of recursive autocatalytic and self-oscillating processes that constituted material for formation of would be biosphere (Hordijk, Steel 2018). To maintain themselves, such processes relied upon regulatory capacities that were based on chemically 'embodied' recurring information flows. The patterns of information circuits constituted early versions of codes.

Marcello Barbieri in his path-breaking article on 'the code view of language' in 'Biosemiotics' outlines three main types of codes—organic, neural, and cultural (Barbieri 2020, 2)[15]. He conventionally insists that it is genetic code that is the primary one and precedes all other organic codes. But in his list of nine organic codes supplementary to the genetic one, there are such that could have evolved much earlier, e.g. sequence, molecular, signal transduction codes. It is highly probable that minimal patterns of information circuits emerged much earlier—right after membranes between the inside and the outside started to regulate balance of thermodynamic and information entropies. Though the status of a code is hardly applicable to the patterns of quantal oscillations, the chemical ones beginning with autocatalytic or even catalytic patterns may be considered kind of rudimentary codes.

Such codes constitute the whole class of related minimal teleodynamical systems called autogens. They are a self-generating system at the phase transition between morphodynamics and teleodynamics—any form of self-generating, self-repairing, self-replicating system that is constituted by reciprocal morphodynamic processes. Autogens include any form of self-encapsulating, self-repairing, self-replicating system that is constituted by reciprocal morphodynamic processes as autogenic, and describing the process, appropriately, as autogenesis (Deacon 2011, 288 ff; see also Sherman 2017, 161 ff. and Fomin 2020, 82—85).

In our search of simplex types of codes it might be promising to investigate the patterns of recurrence typical not to genetic instances sensu stricto but to epigenetic or even morphogenetic processes starting with Turing patterns (Turing 1952) and embodied in auto-oscillating chemical reactions similar to Belousov—Zhabotincky or Briggs—Rauscher ones (Pogodaev, Wong, Huck 2017). Anyhow, all such patterns of information circuits are intensely and solidly embodied into respective substances. It would be rational to look for materializations of the coding information patterns and even for stable material medium that can serve to fix signals. At this juncture it is most appropriate to remember August Kekulé and his magnificent discovery of benzene ring. In his celebrated article of 1865, he suggested that benzene linked six atoms of carbon with six atoms of hydrogen into a closed chain ('chaîne fermée') swinging into a circular configuration (Kekulé 1865, 100). Kekulé shaped such a closed chain with alternating univalent and bivalent bonds into a perfect hexagonal rotation. The very alteration of single and double valencies[16] would make benzene ring both dynamic and stable all at once.

Benzene ring is an uncharged, non-polar molecule with very special properties that are mainly effects produced by the delocalized electrons making up 'additional' three linkages 'above' the ordinary six ones. While their ring-like hexagonal six-corner enclosed chain is highly stable, delocalized electrons not only reinforce the structure, but also 'grab' various atoms and potential component molecules. The resulting polycyclic aromatic hydrocarbons are numerous and diverse combinations of benzene rings shaping into chains, surfaces, and all other kinds of configurations.

Benzene rings are the core structures of polycyclic aromatic hydrocarbons (PAH). They are widespread on our planet and in fact in the entire observable universe. So it is only natural that PAHs have been suggested as highly probable starting building blocks for abiotic syntheses. Such building blocks could also serve much more subtle and complex sequences and cycles of syntheses that could lead to emergence of the earliest forms of life

15 Cf. other claims on multiplicity of codes (Ilyin, Fomin, Khlebnikov 2020; Zolyan, Zhdanov 2018; Zolyan 2020; Lacková 2018; Faltýnek, Zámečník, Lacková 2017; Faltýnek, Lacková, Matlach 2017 etc.)

16 The planar orbital description of benzene hexagonal molecule implies three delocalized covalent bonds (each covalent bond entangles one atom to overlap two lobes of an orbital on another atom crosswise) with all six carbon atoms concurrently resonating delocalized electrons. Thus, benzene is typically portrayed as a circle inside a hexagonal layout.

(Levchenko, Kazansky, Sabirov 2018). The PAH world hypothesis quite consistently stipulates that polycyclic aromatic hydrocarbons could constitute background milieu and abundant organic material leading to ribose chain building and formation of ribozyme-like structures (Platts 2005; Platts 2006; Ehrenfreund et al. 2006). This in turn opens up prospect for the RNA world and forms of life as we know them.

Autocatalysis is instrumental in providing the basic transcripts of ribosomal RNA. Base-pairing within ribosomal RNA sequences commonly forms stem-loop configurations utilizing patterns of recurrence, e.g. folding (Lacková 2020). Thanks to those configurations, ribosomal RNA can form tight and specific interactions with ribosomal proteins to form ribosomal subunits. The ensuing interactions coupled with the association of the small and large ribosomal subunits develop an operational ribosome capable of synthesizing proteins. In the end, biological metabolism itself appears as an extensive autocatalytic set where base-paring, stem-looping, folding and other recursive processes and dynamic patterns provide life-sustaining chemical reactions.

Evolutionary forms of life internalize environmental productive factors by their duplication, recursion, enclosing, folding, etc., and thus eventually shape them into genetic agency (genome plus coding bases of gene expression). Organismic symbiosis creates and initially depends upon ecological context. Self-enclosure of respective systems consolidates such systems within their Umwelts. The sequential phases of unbinding—rebinding result in interiorization of the structural frames of the Umwelts and consolidate a shadow-copy of genetic agency in the form of epigenetic coding complexes fixed in the genotype-phenotype extend. Two trends ensued: one tracked outwards, and another one inwards. Symbiotic bodily organismal incorporations ensue ever elaborate organisms. Symbiotic ecological assemblages develop into stabilizing self-regulated ecosystems. Resulting complex systems rely upon branching structures of information flows, which in their turn utilize first-order signal systems as internalized and decontextualized environmental productive factors.

EMERGENCE OF SIGNAL SYSTEMS AND COGNITIVE ABILITIES

Signals are nearly as old and as quanta themselves. To that effect they are likewise 'primary' and basic. Even if you put aside cognitive prerequisites of quanta modeling by Albert and others, energy and momentum quantization alone already imply alternative states and related effects. In this case, effect of 'co-relating' alternative quantal states would clearly resemble the configuration of Shannonian signal.

What is signal? Interpretations would range from a complex one of a codified dispatch or a part therein that changes mental awareness of the parties involved to a simplex one of a singular energy impulse that makes any kind of difference. Whatever the understanding or definition of a signal may be, one cannot do without, for instance, making judgements on mental or physical alterations actually happening or at least implied. Again, the implicit cogitation inference is altogether tangible and quite certain.

Evolutionary types of signals include quantified ones that emerge in quantum, physical, and chemical domains. They upgrade with evolving structuration and functional loading into autopoietic and biological signals and signal systems. Already at the early evolutionary levels of eukaryotes and probably even with prokaryotes like bacteria, some kind of protocognitive abilities may emerge to register and react to changes in their environment or Umwelt. Such abilities are essentially metretic or suit to register sensations by their intensity and thus to 'measure' them. This type of ability with evolutionary complex-simplex transformations evolutionarily upgrades into exquisite methodological skills of calculus, computation, and statistics.

With neural networks of advanced creatures, reflexive signals shape into cognitive signal systems and evolve autonomous cognition parallel to and duplicating neural processes. Animals get abilities to grasp complex signals, recognize patterns and construe images. The status of vegetative tropisms is not clear. Since plants, fungi, and other creatures build up symbiotic complexes, their tropisms may provide far more complex cognitive abilities than just sensory reactions, their ranging and ranking (Baluška F., Miller Jr., W. B. 2018). Anyhow, in plant communities and also in complex biocoenoses, tropisms with complementary use of various signals and distributed signal systems may acquire more advanced cognitive potential, which requires subtler research.

Duplication of embodied signal systems (neural processes or bio-functional networks) into virtual information systems reveals creation of intraorganismal or extraorganismal distributed cognition practices and their coding apparatus. Higher symbiotic animals evolve ability to collectively use their cognitive capacities with emergence of reflexive cognitive abilities that allow to evaluate their collective and individual performance and functions up to the level of interpretation. Intraorganismal expression, translation, transcription, and other information flows evolve into extraorganismal information flows with their distributive use by a population of organisms that are typically symbiotic. As a consequence, disembodied virtual cognition or proto-consciousness evolves. Deeply entrenched presumptions or in fact doctrinaire convictions that individual consciousness is fundamental and constitutes the cornerstone of any developed cognition are futile and highly erroneous. It takes quite a long timespan and a variety of evolutionary trials to make organismic cognition fully autonomous and individual sensu stricto.

ANTHROPOGENESIS

Anthropogenesis 'dived out' of the fuzzy and transitory stage of cosmic and biological evolution when the original

incompleteness of nature was filled up to the crucial juncture where autopoietic living flesh still lacked self-expression and ability to instrumentally modify and advance evolution. The nightingales had been already trilling, the peacocks were unbolting their magnificent tails, and the monkeys were playing manipulative games with objects and early humans of the Homo genus (Homo habilis, Homo erectus etc.) started to use sticks, shells and stones for easier access to food. However, the voiceless and mindless biosphere still lacked its own twin—the superstructure capable to provide the evolutionary options. Advanced species and organisms already developed quite a developed psyche. There are different ways of self-expression and even communication with each other up to animal games of various kinds. What is missing? Where and what is the lack that, through the next act of emergence, will move on the evolutionary chain of development into a series of regular emergences and new opportunities?

At this juncture, equally voiceless and mindless early Homo with all their symbiotic potential still had not used it to upgrade it to what later turned out into domestication of plants, animals and their own self-domestication. They also lacked capacities to upgrade their neural and psychic potential to a new evolutionary grade of consciousness and self-consciousness. Early humans—cramped within their bodies and immediate Umwelten as well as momentary timespan of present—would know how to extend it and master alternative imaginary worlds of the past and the future, and would be contrafactuals of their purposeful intellectual activities.

Let's try to imagine how this majestic 'diving out' could had happened. It was necessary that one of these perfect beings should had become somewhat less perfect in something, so that the filling of this deficiency may lead to an emergence of a completely unprecedented ability to speak and think from prevalent voicelessness and thoughtlessness. Operationally it was provided by downgrading—similarly to the first catamorphic phase of catalysis or relaxed selection phase when relative epigenetic (not genetic) degradation made some of the structures and functions underused and thus conditioned functionality and evolutionary relevance of the underused potential (Deacon 2010). Manifestly advanced populations of Homo had to migrate into more promising environments where they could afford to be 'underfit' rather than 'overfit' in the logic of doctrinaire natural selection with maximizing fitness. With the 'out of Africa' migrations of *Homo sapiens* (not fully sapiens then) in at least two waves—the first one about 130 to 100 millennia ago and the second one from 70 50 millennia ago—diverse populations of our foreparents confronted a variety of conditions which could lead to a relaxed selection and uploading underused psychic and communicative aptitudes with new skills. After a probable series of local and short-lived trials approximately 60 to 40 millennia, or about a half a thousand human generations ago, an evolutionary transformation took place in the Mediterranean basin, or most likely in the segment between the Mediterranean and the Great Glacier. In any case, the Aurignacian Cro-Magnon culture is often considered typical or even prototypical. Similar archaeological finds are dispersed less densely almost all around the perimeter of the Mediterranean, including the Aterian culture in Africa and the Emiran culture in the Middle East.

Remarkable cave drawings were accompanied by numerous signs of the so-called behavioral modernity. This was a time that is referred to as the upper Paleolithic revolution (Vishnyatsky 2000) or the Great Leap Forward (Diamond 1989), although it would be more appropriate to call the Human revolution (Hockett et al. 1964; Mellars, Stringer 1989). This landmark event is distinguished by archaeological finds that include such signs of behavioral modernity as burial sites of the deceased, rituals of decorating their graves with flowers and artifacts, art, and musical instruments, bone tools, including needles, harpoons, and fish hooks, more advanced dwellings and hearths, etc. (McBrearty, Brooks 2000; Kissel, Fuentes 2018; Kellogg, Evans 2019; Vyshedskiy 2019).

The Human Revolution was quite a protracted period of dozen or more millennia. It took about three to four hundred generations. Just compare it to about a hundred generations of our written history or just slightly over a dozen generations of modernization. Naturally, the change was not momentary and included many phases that tried and fixed different capacities. Acquisition of speech, language, thought, intellect etc. was gradual—contrary to prevailing presuppositions. Many generations of our ancestors could already use vocal speech, but would now any kind of systematic language, associative thinking without rationalized one. But even to start their successive and punctuated acquisition, our ancestors had to master more basic agentive capacities and logonomic systems without either speech and language.

EMERGENCE OF HUMAN AGENCY AND LOGONOMIC SYSTEM(S)

Human revolution would have been impossible if evolutionarily prior to it, our ancestors and their close kin (the other species of homo clade) had not developed drivers to make it. They were advanced hominide agency and logonomic systems. Already species of the Homo genus might had used stone tools and developed mental interactions:

"[…] some form of symbolic communication may be traced 2 million years into the past, roughly contemporaneous with the first appearance of stone tools. This poses the possibility that brain structure and languages have long been bound together in a coevolutionary feedback and have each significantly affected the form of the other. This may help to explain why human cognitive abilities have become so divergent from those of other species" (Deacon 2017, 225).

Many of our communicative abilities are evolutionary very deeply rooted. Thus, it has been reported that William

Fitch got a macaque monkey named Emiliano to utter various sounds while subject to X-ray video recording. The video was used to make a model of Emiliano's body parts that created all of its possible sounds. The model determined which vowel and non-vowel sounds Emiliano could make. An experiment with Emiliano computer simulation allowed to produce an utterance "Will you marry me?" in quite a discernable way. That proved that the anatomy of monkeys does not limit them from producing complex humanlike utterances. William was able to conclude that with a human brain a macaque would be able to talk (Fitch et al. 2016; Fitch 2020). The point is that macaques and even chimpanzees do not have human brains and mentality. Probably, they evolved in a coordinated way, though not momentarily and in a prolonged double-track evolutionary timespan. The concluding stages of that process were related to emergence and expansion of our species: Homo sapiens sapiens.

Our ancestors, or Cro-Magnon, lived among species of homo sapiens neanderthalensis and homo sapiens denisovan. These were distinct populations of the same homo sapiens subspecies. Despite all their differences, the species remained integral—for example, they all copulated and produced offspring. But at the same time, they apparently differed not only biologically, but also in their adaptability and attachment to the environment. Neanderthals and Denisovans were better adapted. Their abilities were almost fully used, but they had to migrate intensively in search of this best environment for them. Cro-Magnons were superweeds (all primates, however, are weeds), that is, they concentrated on ecotones, edges. They had many poorly or almost completely unused 'useless' (non-functional) abilities. Their poor fitness allowed them, however, if not so effectively, but still to survive in a much more diverse environment. It is believed, for example, that the more massive, stable, and clumsy Neanderthals successfully competed with the cave bear both for a place to live and for food. It was much more difficult for the double sapiens, but they could also settle in caves already liberated by the Neanderthals, or they could settle in the steppe in a kind of Yurt made of animal skins or in forest huts.

All people from Cro-Magnons (double sapiens) to Neanderthals and Denisovans (single sapiens) used imitative vocal-gestural reinforcement (duplication) of their actions and interactions. Some speech acts were produced and contextually used. Some thoughts arose. These proto-words and proto-thoughts in Neanderthals and Denisovans were functionally loaded and rationalized. Each time a situation occurred, they interacted with gestures and shouting like other social animals. It is even possible that the repertoire of relatively stable gestures and cries was larger than that of other primates and other animals. However, their functionality remained situational and contextual. Proto-speech and proto-thoughts were created anew each time here and now, only in the present moment to solve a specific problem.

For Cro-Magnons, the same proto-speech and proto-thoughts were much more functionally loose, useless. They used them extremely inefficiently in redundant games. In addition, they formed an 'ugly' larynx with vocal folds, which strictly speaking had a protective function of breathing, and then developed an unnecessary function of vocalization. The larynx was down, and the root of the tongue was buried in the pharynx. This further diversified the extra, 'unnecessary' sounds and complex, composite ones, e.g. those based on the exhalation. Other primates make sounds only when they inhale. And it was easier for double sapiens to play with a much more resonant voice when they exhaled. It turned out a kind of singing. The sounds became melodious, smooth. They could be played uselessly without regard to the situation and the demands of the moment.

The double sapiens also used their psyche in a non-functional and irrational way—instead of practical use, for an empty semblance of fun. It was something vaguely like a fantasy, a useless, excessive game of emotions of fear, joy, etc. And it was much easier to enter into a state of empathy and shared experience of imaginary emotions with the help of smooth howls and drawling chants, as opposed to functional shouts.

UPPER PALEOLITHIC CRISIS AND THE HUMAN REVOLUTION

Such different populations of sapiens co-existed—some adapted tightly, efficiently and concretely, others carelessly, but in a much more diverse environment. But here, approximately in the interglacial period, some 60—50 thousand years ago, there was a powerful shake-up, an environmental crisis. First, the great glacier in the North of Europe and the small ones in the Alps and partly even in the Pyrenees began to melt, and then to melt more intensively. New rivers, lakes, swamps, hills, and depressions appeared, and the sea level rose. Landscapes, climate, and living conditions changed. People of different populations had to find new places to eat and live. They had to change their habits and develop new skills. Those who were too functional and advanced had a hard time. Survival was better managed by low-functioning and degraded people. They turned out to have unused functionality that could be used in unexpected ways.

Neanderthals, apparently, could not adapt and by the forties of the millennia, they were mostly extinct. The new cold snap finally finished them off. The Denisovans also died out, but in some places, they probably endured in human remembrances as 'snowmen'. On the contrary, Cro-Magnons survived and multiplied. They followed not a purely Darwinian adaptation of the fittest, like the misfortunate Neanderthals and Denisovans did, but rather the contrary. Humans were less adapted, even 'degraded' with 'useless' abilities, but more labile. They somehow managed to adapt to a sequence of changes and multiplicity of up-and-coming conditions. A better fitness of Neanderthals or Denisovans would not work since the corresponding

conditions simply disappeared. Their maximal fitness turned dysfunctional and eventually fatal.

Under these conditions, it turned out that the degradant sapiens were able to experiment and adapt. In addition, they were helped by previously useless sound and gesture games in conjunction with equally useless fantasy. They duplicated, repeated, and reinforced each other. As a result, the Cro-Magnons combined their fears, expectations, and hopes with shouts and gestures to act beyond their biological capabilities in a humanlike way. New social abilities began to emerge.

Our ancestors began to turn their former instinctive and situational communication (proto-speech), which was context-dependent, into more humanlike speech, which was maintained and stabilized not by contexts alone but also by mental frames that decontextualized contexts into regular patterns of habits. They consolidated these skills with a stable system of speech generation and understanding of would be language. Thus, glottogenesis began. They transformed from unstable situational fantasies into joint, shared thoughts, which were fixed in a stable mind (thinking, cognition), in a system for producing thoughts, in the generalized ability to think. So noogenesis began. But all those innovations remained conjoined with behavioral habits and patters of interaction. Altogether, this manifested into logonomic systems of the integral human behavior, thought, and speech.

Speech and thought, language and mind (cognition) became the main achievements and resources of double sapiens, their competitive advantages in comparison with Neanderthals and Denisovans. They were supplemented by other capabilities, including improved types of memory (working for focusing on actions and episodic for mental travel), internal speech and establishing causal connections, and imagination (Kellogg, Evans 2019; Vyshedskiy 2019).

Speech and thought activity, voice and thought were mutually synchronized, and language and thinking were mutually supported. Cro-Magnons developed human social advantages that dramatically increased their adaptability. Their solidarity and mutual assistance increased significantly and became incomparably more effective than the solidarity of Neanderthals and Denisovans. The double sapiens came to each other's aid faster and more amicably. They responded to threats faster, found solutions faster. And most importantly, we interacted more clearly, faster, and more reliably at every stage.

That's how lucky the population of double sapiens was, to which we belong evolutionarily. Our ancestors consolidated the ability to regularly use joint cognitive (thoughts) and speech (voice) acts that more and more systematically duplicated each other. These dual systems—cognitive and speech—have evolved into thinking and language that no one has ever had before. Becoming behaviorally modern, people were able to start singing, laughing, grieving, and rejoicing, and most importantly to fantasize, think, and find solutions, pass on their inventions and discoveries to each other, and through songs and fairy tales to new generations.

Fifteen hundred generations ago with the human revolution our ancestors started a great pursuit to create humanity, first in many tiny humankinds—first primitive herds and flocks, then genera, phratries, and tribes. They have the opportunity to converge, to add small communities to larger and larger ones, so that eventually the convergence of a globalized, noospheric humanity is achieved.

Emergence of human communication and its advancement into language and thought. It is believed that quite modern language and thinking arise simultaneously (Clark 1970, 146—147; Clark 1995; Noble, Davidson 1991). There is every reason to believe that it was during these times, forty millennia ago, that language emerged as a fundamental human ability and a conditional proto-language, which gave rise to the supposed megafamilies of languages, which became the loci of the reconstructed macrofamilies of languages and of the subsequent formation of the current language families. It is unfortunately extremely problematic and actually impossible to reconstruct the initial languages of Cro-Magnons or their core lexis: "40—50 thousand is the maximum, because those macrofamilies that we know are dated about 15—17 thousand. Two information brought together by other linguistic families may require another two or three floors, but the starting point cannot be older than 40—50 thousand years, otherwise global etymologies would not have survived, otherwise we would not see anything at all" (Starostin 2010, 7).

Along with sociality, thought and language are the main distinctive qualities of humans. But their emergence remains by and larger enigmatic. One of the most acknowledged reasons is the lack of direct evidence. It is a common problem for any studies of evolution and emergence. In the cases of glotto- and noogenesis, far more serious obstacles still prevail due to entrenched research fallacies.

It is worthwhile to introduce a hypothesis about stepwise emergence and advancement of human language and thought in a series of internalizations of communicative contexts (frames, typical communicative settings, mementoes and typical remembrances etc.) into codes of the first, second and further orders.

AU LIEU DE CONCLUSIONS. LINGUISTIC FRONTIERS OF EMERGENCE AND EVOLUTION

This overview of selected instances of emergence and evolution has an immediate double purpose: (1) to sum up a major bulk of the work done by the INION Center for Advance Methods and the RSF project on knowledge transfer and methodological convergence, (2) to sketch an anticipative agenda for further studies of emergence and evolution with particular emphasis to problematic 'bottlenecks' of research and the related promises of momentum. Still a more critically important purpose is to consider linguistic frontiers of evolutionary studies.

Present-day linguistics is not disposed to study broader *problématiques* of emergence and evolution save glottogenesis and language acquisition, e.g. languaging and translanguaging. But even those remain comparatively peripheral in current language studies despite some impressive results. For language origin, I would mention Michael Corballis, Daniel Everett, and William Fitch while for language acquisition and languaging Simon Kirby and Stephen Cowley.

Ironically, such promising trends as language acquisition and languaging, social semiotics and multimodality as well as systemic functional linguistics remain divorced from evolutionary studies and evolutionism. Their exaggerated concentration on current everyday practices appears both ridiculous and confusing. It is within evolutionary vista that those and similar domains of linguistic research can find their proper roots, proclivity, and worth. Evolutionary typology of human communication could make any temporal and momentary instance of multimodal semiotic interactions meaningful. Similarly, the same typology could provide valuable guidance to SFL proving broader relevance and fuller meaning of its dimensions and formalisms.

An immediate prospect could entail research of primate and hominins' behavior modes, their further multiplication both functionally and structurally in incessant transformations from embodiments to informational disembodiments and back with all kinds of agentive membranes and interfaces. Techniques of correlating the inside and the outside of phenomena, recursion and enclosure, duplication and metamorphosis could provide novel options of understanding and interpretation sequential advancement of ever more versatile and numerous modes and forms of communication and cognition.

Outdated delusions of simultaneous and miraculous emergence of intellect and thinking, of language and speech still remain common wisdom of prevailing multitudes. Recent advances in evolutionary anthropology, paleo- or archaeogenetics, archeology, and neuroscience make sequential emergence of human capacities not just plausible but essentially confirmed. One of the most advanced schemes of sequential emergence of human capacities and communication/cognition modes (Everett 2017) can be substantiated by language acquisition studies and multimodal analysis while SFL and social semiotics can help to outline a comprehensive theoretical-methodological framework for the overall structural-function evolution. This can be accomplished only with a clear evolutionary turn in modern linguistics and its foremost domains just mentioned.

The key research domains from social semiotics to languaging might be able to play this crucial role if they seriously reshape their methodological and operational toolkits. What could appear as an important resource are simplex-complex transformations, recursion and enclosure, models and more subtle modules of agency structured by an interface (membrane) for the inside and the outside with overlapping quantum-like totality, e.g. quantum model of morphogenesis (Melkikh, Krennikov 2018). Such a promising outcome is not failsafe and in itself constitutes a challenge. It implies that in the long run, convincing validity of outlined logic can be confirmed only by a systematic and detailed study of inclusive number of cases and sufficient factual material. Thus, the article provides a theoretical point of departure and general methodological guidance for empirical studies of evolutionary transformations.

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