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ВОЗНИКНОВЕНИЕ АБСТРАКТНОГО МЫШЛЕНИЯ ЧЕЛОВЕКА ПОД ВОЗДЕЙСТВИЕМ КОММУНИКАТИВНОЙ РАСПРЕДЕЛЕННОСТИ

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Аннотация: Человек, принадлежа к млекопитающим, обладает как разнообразными способами информационного взаимодействия, свойственными животным этого класса, так и специфическими, а именно – высоким уровнем абстрактного мышления, языками и беспрецедентной социальной активностью, результатом которой является создание культур. Человек выделяется поразительным умением координировать свои действия с другими людьми, и существование человеческих сообществ зависит от разделения когнитивных усилий между их членами, от распределенности познания. В статье выдвигается тезис о том, что социально распределенные когниции человека являются результатом развития биологически распределенных когниций, которые эволюционировали параллельно с развитием коммуникативных форм социального взаимодействия. Биосемиотический подход описывает человека как очень сложную динамическую систему, вовлеченную в непрерывную многоаспектную коммуникативную деятельность. Вместе с тем, многие аналогичные информационные процессы осуществляют все живые системы, что позволяет сделать вывод о том, что низший уровень абстрактного мышления вполне мог сформироваться в рамках пространственного мышления, доминирующего в режиме коммуникативного взаимодействия со средой *on*-line. Выдвигается предположение, что впоследствии данный первоначальный уровень абстракции смог достичь высокого порядка у человека благодаря возникшим способам коммуникации *off*-line. Таким образом, возникновение высокого абстрактного уровня мышления и широкой семиотической компетенции у человека явилось результатом принципа дополнительности биологически и социально распределенных когниции и коммуникации. История человеческой цивилизации свидетельствует о дальнейшем усилении позиций *off*-line коммуникации. Именно сдвиг в сторону информационного обмена *off*-line способствовал беспрецедентной социальной кооперации людей благодаря распределению когнитивно-коммуникативных процессов среди членов социальных групп независимо от ситуации «здесь и сейчас».

Ключевые слова: эволюция; абстрактное мышление; пространственная когниция; абстрактное мышление низшего и высшего уровня; *on*- and *off*-line коммуникация; распределенное познание и коммуникация; происхождение языка

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HUMAN MENTAL ABSTRACTION SPECIFICITY EMERGENCE UNDER DISTRIBUTED COMMUNICATIVE PRESSURE

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Abstract. Being mammals, humans both share with other animals varied forms of information exchange typical for that class and have something that makes them different, i.e. higher-order thinking, languages and unprecedented social activity resulting in a great diversity of cultures. People are particularly skilled in coordinating their activities, human communities rely on mind-sharing that is realized through distributed cognition. It is argued in the paper that human species' socially distributed cognition is an extension to their biologically distributed cognition both being inseparable from distributed communicative interactions. From the biosemiotic perspective, humans can be described as very complex dynamic living systems that are continuously involved in multifaceted communicative

activity but so are all living systems, and lower-level mental abstraction could have evolved in terms of spatial cognition employed in *on*-line communicative interaction with the environment. It is proposed that that initial level of mental abstraction could then advance into higher-order thinking when humans developed communication *off*-line. Thus human semiotic mind specificity became possible due to biological and social distributed cognition and communication complementarity. The recorded history of mankind gives evidence that the focus on the *off*-line communication has been increasingly rising ever since. The shift from *on*-line to *off*-line interaction ensured the unparalleled social cooperation due to the distribution of cognitive processes across the members of a social group independently of 'here and now'.

Key words: evolution; mental abstraction; spatial cognition; lower-order and higher-order mental abstraction; *on*- and *off*-line communication; distributed cognition and communication; language origin.

Introduction

Specificity of human intelligence is usually equalized with the exceptional level of abstract thinking it possesses – the ability to perform different mental operations in situations where the schemes and images that are voluntarily retrieved and operated upon in the mind are not directly connected to the structure of the moment. That level of mental activity is not necessarily activated under the pressure of some urgent need in the circumstances of 'here and now' but is initiated by the individual himself for purposes quite often not stipulated by the survival. Human cultures consist of a great number of objects of art that are created for the sake of art and do not ensure the entire species biological continual existence. Nevertheless, that capacity of extreme abstract thinking has not come out of the blue.

There is a stable tendency in cognitive linguistics and psychology to explain this special human power in mental abstractness by language capacity innateness (Noam Chomsky's Theory of Universal Grammar (1965) and Eric Lenneberg's Critical Period Theory (1967), later developed by Stephen Pinker into language instinct (1994)). The use of languages that are unmotivated symbols and rely on individual's ability to memorize huge amounts of words and structures demands particular mental skills. Thus the conclusion about language innateness seems to lie on the surface as, judging by their behavior in natural environments, none of other biological species demonstrate anything similar to human verbal communication and none have ever approached humans in creating anything similar to their cultures. Language extreme importance in men's modern societies is unprecedented, and it would be absurd to deny the impact of language on the development of abstract cognitive abilities of an individual: in modern humans thinking and languaging have become practically inseparable.

The omnipresence of language is the fact of contemporary human cognition and communication but not all individuals master that skill even nowadays. But what was the case at the dawn of human civilization? By taking the point that it was language that enabled mind to increase its potential in abstractions, we find ourselves trapped in the long known evolutionists' problem: was it language that changed the mind or was it the mind that invented the language, the notorious "hen first – egg first" deadlock. Even admitting the crucial role of language in evolution, we have to agree that language in any form no matter how primitive (often referred to as protolanguage) demands considerable proficiency in cognitive computational mechanisms and verbal propositional thinking. In that case, it seems that the innate biological underpinnings of language acquisition are overemphasized. To conclude, the problem of mental abstraction emergence appears to be central in explaining how language evolved.

In my opinion, the emphasis is to be made not on *the language – mind co-evolution* but on *the semiotic capacity – mind co-evolution and development* [1]. To show that this paper is based on several assumptions:1) cognition must not be separated from communication, and both should be treated as two components of the same phenomenon; 2) cognition and communication are extremely diversified and distributed; they bear nonlinear traits; 3) high-order mental abstraction is not an exceptionally human prerogative, and there is continuity across species in biological and social cognition; 4) language is a social phenomenon, not a biological one; it is only one the plethora of codes used in human cultures; 5) human specificity emerged when early *Homo* made preference for *off*-line communication.

Concrete and Abstract Semantics Paradox

High-order mental abstraction can be explained by the natural evolutionary development of *concrete/abstract* thinking mutuality. Most probably, human abstract finesse developed from the initial level of abstract mental operations that make possible concrete / practical thinking not only in humans but animals as well.

Extended research on brain asymmetry revealed neuroanatomical differences between the left and

right hemispheres that are responsible for lateralization of brain functions. That discovery gave rise to several dual-processing theories of the mind: "Dual-process theories have taken on various forms (e.g., see Evans, 2008 for a review). Nevertheless, there are some common features. First, these theories tend to explain the working of the human mind in terms of two qualitatively distinct cognitive systems, and are referred to as type 1/type 2 (Goodwin & Wason, 1972), System 1/System 2 (Stanovich, 1999), or intuitive/deliberative (Kahneman, 2003). Moreover, these two kinds of cognitive systems tend to be differentiated along the following dichotomies: unconscious/conscious, fast/slow, automatic/controlled, emotional/rational, intuitive/rule-based, etc." [22, p. 1673].

Complexity of mental processing allows postulating other types of dichotomies, including the opposition *concrete / abstract* which can be derived from the Dual-Coding Theory (DTC) developed by Alan Paivio in the 1970s [19; 20] according to which both visual and verbal inputs of information are processed differently. Two opposing cognitive systems are responsible for internalization and transformation of the incoming data: *image-holistic* that operates percepts converting them into representations in a form of mental analogue codes; and *verbal-propositional* that deals with symbolic mental codes: "The systems are assumed to be composed of internal representational units, called logogens and imagens, that are activated when one recognizes, manipulates, of just thinks about words or things. The representations are modality-specific, so that we have different logogens and imagens corresponding to the visual, auditory, and haptic (feel), and motor properties of language and objects. The representations are connected to sensory input and response output systems as well as to each other so that they can function independently or cooperatively to mediate nonverbal and verbal behavior. The representational activity may or may not be experienced consciously as imagery and inner speech" [19, p. 3].

Imagens are mental constructs that accumulate information about objects of reality in analogue forms, i.e. images are similar to natural objects and keep in memory their holistic parts, shapes, colours, etc. Imagens are the result of the entire body interaction in the environment in the real time mode, and the multiple channels of perception reflects the fragments of reality in their integrity at once. Thus imagens possess qualities of continuity.

Logogens are discreet units, rely on unmotivated language symbols and operate sequentially. To create a coherent utterance a speaker selects the necessary concepts, organizes them in a certain form of thought then encodes them by words in a syntactically appropriate sequence in a sentence. Both imagens and logogens are interconnected, and the processing of information can be interpreted in terms of the embodied natural translation that mind performs continually [11].

Concrete / abstract thinking dichotomy helps to better understand the two aforementioned cognitive processing systems and explain how it happened that in their co-evolution the latter became dominant in human mind.

Though definite criteria demarcating higher animals' and humans' thinking have not been given yet, it is repeatedly stressed that only people have a quality of abstract / higher-order, or conceptual [17] / off-line thinking [4]. Both socio-cultural and biological theories of intelligence specify human intellectual uniqueness according to the ability to perform mental operations in an abstract mode. Unfortunately, the idea of the abstraction is treated in modern science ambiguously. A couple of definitions demonstrate that:

"Abstract thinking is a high-level thought process. Someone who is thinking abstractly is considering a concept in a broad, general and non-specific way. Abstract thinking is the opposite of concrete thinking" [27].

Or: "abstract thinking – the final, most complex stage in the development of cognitive thinking, in which thought is characterized by adaptability, flexibility, and the use of concepts and generalizations. Problem solving is accomplished by drawing logical conclusions from a set of observations, such as making hypotheses and testing them. This type of thinking is developed by 12 to 15 years of age, usually after some degree of education. In psychiatry, many disorders are characterized by the inability to think abstractly" [18].

According to these definitions abstract thinking is the highest form of individual and cognitive development that only humans have acquired in the course of evolution, and it is always described as standing in contrast to concrete thinking which is believed to be easier to define. At least the same Mosby's Medical Dictionary characterizes it as: "a stage in the development of the cognitive thought processes in the child. During this phase thought becomes increasingly logical and coherent so that the child is *able to classify, sort, order, and organize facts* while still being incapable of generalizing or dealing in abstractions [italicized by N.A.]. Problem solving is accomplished in a concrete, systematic fashion based on what is perceived, keeping to the

literal meaning of words, as in applying the word horse to a particular animal and not to horses in general. In Piaget's classification this stage occurs between 7 and 11 years of age, is preceded by syncretic thinking, and is followed by abstract thinking".

Though I am skeptical about children's inability to apply the word horse to horses in general before they are 7, the main idea is (or better say – seems to be) clear – practical everyday thinking is connected with familiar routine surroundings filled with trivial/concrete things that people manipulate mentally mostly in the automatic mode. Still concrete thinking is not defined as a positive concept with its own clearly identifiable traits, but is presented just as a stage on the way to abstract thinking acquisition. The reason for that is that a more careful observation shows the impossibility to separate the two. Gideon Rosen [24] states:

"The abstract/concrete distinction has a curious status in contemporary philosophy. It is widely agreed that the distinction is of fundamental importance. But there is no standard account of how the distinction is to be explained. There is a great deal of agreement about how to classify certain paradigm cases. Thus it is universally acknowledged that numbers and the other objects of pure mathematics are abstract, whereas rocks and trees and human beings are concrete" [24].

The last point is on the one hand sensible but on the other circular. It is true that abstract ideas (not only numbers, but such notions as happiness, democracy, etc.) *a priori* are opposed to concrete objects existing in reality – virtual concepts and physical objects possess entirely contrasting characteristics. But as to the sphere of mental activity the case is absolutely different – representations of all objects – both concrete and abstract – are semantic entities and exist not in reality but in the mind of an individual and their status is equalized. The opposition concrete – abstract obviously belongs to the sphere of semantics, and it is logical to apply it to the content of mental concepts which are considered to be the constituents of thoughts [23]: concrete concepts replace real objects of the world in the mental lexicon while abstract concepts represent non-existent entities that are products of the mind reasoning.

Nevertheless, when the notion of abstractness is discussed in terms of mental activity a lot of confusion arises from the very start. Any attempt to separate concepts of abstract objects from the concepts of concrete ones is groundless as the word object cannot be applied in the same sense to concepts that are abstract things by default and do not exist in reality, are not tangible or within the grasp of the senses. Similarly, the word concrete is not fully relevant even when applied to concepts of real objects which are part of the mental sphere. Concrete objects concepts are usually described as equal to the objects of reality they represent while they must be treated as abstract, too – mental representations (including perceptual images) only represent real objects in the individual's mind and are abstract, so to say virtual, *per se*. It follows that when speaking about mental processes we should distinguish the degree of abstraction that certain mental operations deal with. To draw a sharp distinction between the abstract and concrete thinking is impossible, and there is no need to do that. Even such purely abstract concepts as numbers and figures historically are linked to concrete notions of "many" and "much" that were designated by ancients in drawings of many objects, or scores of stones and shells.

The attempts to explain the peculiarities of concrete thinking by the mental operations involved in the problem-solving of the *here-and-now* moment reveal only half-truth. A closer observation shows that all mental processes are performed in an abstract way, even those going on in real time, even those based on the so called spatial cognition that involves the individual's physical presence on the particular environmental scene. When, for instance, I am walking down a path in the forest and see a big tree lying in front and blocking my way, I do not pull or push the trunk, neither do I try to perform physically any other scenarios of the problem-solving so that I could choose the best one which is absurd. Instead I first observe and estimate the situation: perceive the tree and objects around it – the size, the distance, the state of the ground on both sides of the path (in case it might be swampy or contain some other danger if I decide to walk around), my outfit (especially my footwear – is it only for walking on dry ground or are they rubber-boots?), my physical abilities (how fit I am for this or that sort of physical activity – jumping or climbing), etc. The listed objects are in front of me, they all are real objects but I operate only with their mental representations while searching for a solution.

What is to be noted here is the fact that I do not rely entirely on the information perceived on-line. I retrieve from my memory similar cases epistemologically acquired during my life and use them while estimating the present situation. Thus my "concrete, spatial" thinking becomes even more abstract as it involves all previous cases of my getting over different obstacles. It is particularly important here that though this sort of problem-solving does not

include our linguistic mind it is obviously based on the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, the ability that is usually unjustly accredited only to human intelligence (see the definition above).

The latter circumstance is very important as there must be similar processes in the minds of other animals. All higher animals when acting in real life coordinate their capabilities with situations around them relying on the previous experience. Deer, cats and other evaluate the distance before jumping otherwise the consequences might be fatal. Puppies that have been hurt by a hedgehog's needles will avoid further contacts as their memories will warn them against that, and when meeting a hedgehog again the incoming percepts (auditory, visual and olfactory) will evoke impressions of the previous contact which will contain the painful tactile component. The fact that puppies become cautious with all hedgehogs shows that they not only learn from experience, but they also develop cognitively and are able to classify, sort, order, and organize facts: they become aware of the danger that comes from all hedgehogs, not a particular one. Definitely it will not be an exaggeration to admit that even animals' minds process data of different degree of abstract semantics.

That the problem of the mind origin in its different varieties is of particular importance for the evolution of life on Earth is addressed in many recent publications about proto-forms of mental activity in the lowest species [e.g., 26; 24]. In his paper presented at the 2012 Gatherings in Biosemiotics (Tartu, Estonia) Alexei Sharov writes that the mind emergence marks a transition from protosemiosis to eusemiosis. He treats mind as a tool for classifying and modeling objects which means that mind must be much more than just molecular signaling, and its origin meant the uncovering of a new threshold zone in the semiotic organization in evolving organisms [15]. According to Sharov, protosemiosis corresponds to the initial level of life origin, i.e. origin of agency (action), while eusemiosis marks the origin of the mind which he describes as the origin of signs/signals that control actions (there must be some form of mediation between action and stimulus): "A primitive form of mind may exist in a single cell, where the nucleus plays the role of the brain. Thus multicellular brains in animals are communities of cellular 'minds' of individual neurons. The ability of agents to classify objects may have originated from their capacity to distinguish states of their own body in order to prioritize various functions" [24, p. 216]. Interpretation at this level of communicative interaction may mean the ability to choose from a set of options the organism confronts with. The author sees another important faculty of the mind at this primary modeling level of semiosis in the ability to anticipate unperceived features of the real world (ibid.) which means the presence of abstract mental proto-abilities in the microworld. Interpretive processes are based on abstraction. The matter of choice presupposes operation with abstract notions already on the binary opposition principle reducible to two main global concepts – good/favourable – bad/unfavourable.

The examples given show that it is certainly difficult to single out either abstract or concrete thinking as both definitely go together, or, better say, that concrete thinking (based on spatial perception) should be taken for the lower level of abstraction in the mind. Any living system must rely on both during its life-term, and what makes the difference is the quantity and quality of abstract thinking used by a species in problem-solving.

Abstraction must be always present when a living-system interprets data from the environment – even on the epistemological level external data monitoring includes such processes as comparing and valuating for further decision making and action taking. Before making a choice, the possible options are to be considered – which of them are favorable/ useful and which are not. Some degree of prognostication is a necessary prerequisite of survival in nature, which in its turn means that such or other abstract mechanisms of mental operations must be present, too. Today the problem of the mind emergence has been moved from the level of humans and non-human primates to much lower species [3; 24] because it has become evident that it is impossible to explain that highly complex dynamic interaction of the living beings if we do not admit the existence of some proto-forms of interpretive mental activity in practically all forms of earthly life.

There is no ground to demarcate perceptual and conceptual levels of thinking as the tendency with evolutionists is. For example, Robert Logan [17] categorically claims that brains of hominids were similar to other mammal brains which were purely percept processors and only language emergence made the conceptual thinking possible: "Words representing concepts allowed a transition from the non-verbal forms of communication and percept based thinking of our hominid ancestors to the verbal form of communication and the conceptual symbolic form of thinking that is characteristic of the human mind. Language is both a form of communication and an information processing system that permitted the

transition from percept based thought to concept-based thought. The spoken word is the actual medium or mechanism by which concepts are expressed or represented. The relationship of spoken language and conceptual thought is not a linear causal one. Language did not give rise to concepts nor did concepts give rise to language, rather human speech and conceptualization emerged at exactly the same point in time creating the conditions for their mutual emergence. In a certain sense language and conceptual thought self-organized" [17, p. 82].

Unfortunately, that approach does not resolve the same old hen-first-egg-first problem. No one argues that language emergence had definitely increased the status of conceptual thinking in humans and made it the principal one that is in charge of Homo socio-cultural behavior. But neither language nor conceptual thinking could have evolved simultaneously, or by chance. There had to be some preparatory stages on both sides concerning moves in growth of distributed semiotic activity and abstract forms of thinking that could have enabled the new cardinal stage.

The biosemiotic perspective with its assumption that communication via different signs is continuous across species, and that biological evolution is not complete without evolutionary semiotics demonstrates that information processing in various animals demands proto-concepts that their minds operate when making decisions [26]. Language as a means of external and social (sic!) communication could have evolved only when the conceptual system (mental lexicon) had been formed. It has already been shown that the semantics of concepts is not equal to the semantics of corresponding words. The latter is much narrower as the speaker can externalize verbally only part of the sense leaving a lot in implication, for instance the nuances of his/her emotional state – human psyche is very rich semantically at any given moment of life. Each human mind is distinctive and singular, and its content is always much more affluent compared to what a person can show outwardly.

The view on the mind as distributed activity [1] on lower and higher levels of abstraction provides the possibility to explain the evolutionary continuity across species in terms of the constant increase of abstract thinking and mind complexity – the higher the class of the animal is the more complex and elaborate behavior the latter demonstrates, and the more multifaceted interaction it has with the environment and other species. Quantitative changes lead to a qualitative response giving rise to a new mental capacity that is built on top of the already existing ones thus forming a hierarchy of the organism's semiotic linkages with the surroundings. Transition to a new level of interaction with the environment is marked by new forms of higher abstract thinking and new semiotic codes acquisition.

Semiotic mind

The dominance of our species on the planet (if we do not to take the microworld into account) is the decisive evidence of our uniqueness which is associated with two circumstances – human language capacity and the celebrated mental abilities. The former seems to be an obvious human benefit over the rest of the animals as no other biological species has ever approached anything similar to human verbal communication. Different varieties of languages are indispensable in the life of human communities and enable interpersonal information exchange to the maximum degree that can be found nowhere else in the living world.

Any discussion of human specificity invariably includes reasoning on both phenomena, and quite often the theorizing reminds of the hermeneutic circle – language is explained via mind while mind is equated to language. Those close ties between language and mind seem to be supported by the fact that specifically human thought processes are performed with the help of mental *verbal* representations, which means we think in language, and language functions in two modes – interior and exterior (I-language and E-language in Noam Chomsky's terminology (1986)) thus servicing the needs of interpersonal social communication and personal auto-communication, the latter can be epistemologically traced by everyone in their own minds.

The contemporary evolutionary theory treats language emergence as a phenomenon inseparable from the formation of the human mind. Purely human intelligence is normally identified with the ability to think in abstractions, or, in Derek Bickerton's words – *to off-think*, by which he implies such a mode of cognitive processes at which mental operations performed with mental representations are not influenced by the situation of the given moment and can refer to events both of the past and prospective future. The ease with which human thoughts flow and combine different verbal concepts on the combinatorial principles leads to an assumption that language and higher-order thinking have always gone together and must have evolved at the same time [4].

Speaking about the evolution of language systems in the brain, Terrence Deacon [7] differentiates two extreme language selection

scenarios that " are commonly opposed in the literature to predict what changes in brain structure might be relevant: scenarios assuming that language is a consequence (or late-stage tweak) of a more prolonged trend toward increasing general intelligence (exemplified by a 2 million year expansion of brain size) and scenarios assuming that language is the consequence of domain-specific neural modifications and is independent of general intelligence" [7, p. 16].

He points out that those scenarios though not mutually exclusive, "do make different predictions with respect to neural structural and functional consequences, as well as evolutionary timing". In the first case language emergence "is likely supported by a significant and extended natural selection history, including the contributions of many genetic changes affecting the brain". If it is of recent invention, there has not been enough time for language functions to be more integrated into cognitive abilities. This hypothesis is "more consistent with language processes being highly modular and domain-specific, localized to one or a very few neural systems, fragile with respect to brain damage and genetic variation" [ibid., p. 16 – 17].

It would certainly be logical to accept the ancient language origin scenario, but the archeological evidence provides arguable evidence for that: "The paleoarcheological record is surprisingly stable from about 1.6 million years ago to roughly 350,000 years ago, with the transition from Acheulean to Mousterian tool culture, but doesn't begin to show signs of regional tool styles, decorative artifacts, and representational forms (e.g. carvings and cave paintings) until roughly 60,000 years ago, with the dawn of what is called the upper Paleolithic culture. This recent transition to technological diversity and representational artifacts has been attributed to a major change in cognitive abilities, which many archeologists speculate reflects the appearance of language. Fossil crania, however, provide no hint of a major neuroanatomical reorganization, and the genetic diversity of modern human populations indicates that there are some modern human lineages that have been reproductively separated from one another for at least twice this period and yet all have roughly equivalent language abilities. These considerations weigh in favor of a protracted evolution of language abilities and for the convergence of many diverse neural adaptations to support language "[ibid., p.17].

The sudden cultural explosion in the upper Paleolithic period must be an evidence of some really important changes in cognitive mechanisms that enabled an abrupt increase in cultural artifacts. But the fact remains that "Despite decades of research to identify the distinctive neuroanatomical substrates that provide humans with an unprecedented faculty for language, no definitive core of uniquely human anatomical correlates has been demonstrated. Only a few distinctive anatomical differences can be directly associated with the human language adaptation. These are associated with the special motor adaptations for speech" [ibid., p. 20].

The conflict will be resolved if we approach the language capacity acquisition from the distributed cognition and communication mutuality perspective and look upon human mind evolution as gradual increase of abstraction due to semiotic competence growth.

Cognition is inseparable from communicative processes, both heavily interdependent: cognition being the sum of knowledge that is vitally important for the species survival and maintenance, to acquire it the organism must develop multimodal mechanisms of interactions with the environment. Multifaceted communication (sensory-motor with non-humans) provides an organism with data that are mutually complementary thus enabling the verification of information received via one channel through the other. In the course of evolution, a dominant sense (e.g. sight in humans and primates) and additional ones are usually developed. Combinations of senses across species are different, and that variability is defined by the habitat and the patterns of the species behavior that the species constantly diversifies to survive and reproduce. The more varied the species cognition and communication are the more chances for success it has. That statement is circumstantially supported by the fact that more cognitively developed animals like mammals are fewer in number compared to lower species – the risks of the extinction are reduced by the input of more diverse data thus ensuring the organism's stability.

Both cognition and communication are always distributed and non-linear. The character of the cognitive and communicative networks of a living being is extremely complex and highly dynamic. The internal vs. external specificity of interaction defines the character of cognitive processes. Cognition underpins the interactions between species and structures their communities.

Jesper Hoffmeyer [11] writes that practically all processes in the animate world are regulated communicatively. The environmental pressure on an organism is so great that by genes alone it is impossible to explain the evolutionary changes a species undergoes. It is the ability of living systems to 'read' signs / signals and interpret them that regulates the mechanisms of adjustability to the instability of the settings. Thus mind is an inherent part of communication and consequently – of semiotic processes. The more diverse a species

interaction with the world is the more complex mental activity it has, the richer its semioticon is the higher abstract operations the mind performs. Language is only one of the communicative means used in modern human cultures and to use it successfully well-developed mechanisms of abstraction are needed. Before language was acquired the mind had to be prepared for it through different communication practices via different signs.

Both thinking (information processing) and communication (information exchange) are dependent on data, and both can be better described as two sides of the same process. From the evolutionary perspective most probably not mind and language but mind and semiotic competence co-evolved. The survival of individuals in the biological world is impossible in isolation from the environment, and the latter provides every organism with huge masses of info non-stop. No wonder both capacities undeniably go together and co-influence each other, but still there is one great distinction between the two.

Thinking is an interior phenomenon, its processes are hidden behind the skull from the outside observer, and he/ she can only deduce what thoughts have preceded the actions performed by the individual under observation. As to communication, most of its forms (except internal processes) are externalized. The physical integrity itself of a living being rests on the interaction with animate and inanimate objects around it. Thus the more exhaustive and detailed data it gets the more verified the understanding of the situation a species has. The constant needs in extra data under the pressure of the changing environment initiate changes in the biological structure of the organism enabling its successful adaptation.

The semantic component is crucial for any communicative act for it is the content, or meaning, that both the addresser and the addressee are in need of. The multiple forms of external communicative interaction that have developed in the course of evolution must have emerged under the pressure of: 1) urgent need in meaningful information, and 2) completeness and full value of the received message. The latter must have always been the matter of particular concern – if losses of information in the course of interaction were too big, the interaction itself would lead to a failure. Thus the search for the most reliable operational mode and channel that would ensure the least possible losses of semantics must have accompanied biological evolution. As a result, the higher the species the more complex and multifaceted external communicative capacity it has (behavioral patterns, gestures, vocal signals, spotting, ``etc.). That shows that one channel of information transfer and delivery is never enough, and species have developed extra pathways that would make a species information safety more stable.

David Kirsh [14] points to one more demand that had to contribute to communicative forms development and precision – the search for means of reducing the cost of information exchange. Though Kirsh writes about the ways external representations enhance human cognitive power, it is plausible that the cost reducing issue is relevant for all forms of biological communication. The best ways of information delivery and transfer are to be the quickest and energy saving to give a species a chance to withstand the environmental threats.

The organism's links with the surroundings are plentiful, its different biological systems establish their own forms of intercourse with the outside providing the body which is a complex integral system with separate flows of data that are to be compared, verified and generalized by its subsystems first, and the results must be amalgamated by the central controller then to create an overview of the situation.

External forms of communicative interaction can be performed in two modes: *on*-line and *off*-line. The *on*-line communication is a model of dynamic interaction in the real-time mode (all communicants function in the same system of time-and-space coordinates, interact directly and process information spontaneously) 'here and now" on the principle of analogue coding. Signs used by the interacting organisms are 'mapped' on their bodies as they communicate via voiced signals, postures and other bodily movements. In the situation of constant scene changing, immediate interaction demands spontaneous reaction (stimulus–response principle) to the received signal (figure). Space domineers in the situation and all components of the scene (ground) are revealed to the perceiving mind. The interacting organisms receive all sorts of the background data through their senses non-stop simultaneously, and they share the same data. The time span is irrelevant; the semantically rich background information of the moment is most significant and defines the character of the spontaneous discourse. *On*-line intercourse is based on the lower-level mental abstraction, and the semantic memory plays a less important role than the operational and the episodic types of memory.

In the *off*-line intercourse communicants are distanced in time and space, they can neither see nor hear each other while generating or receiving a message. That type is basically autonomous as the addresser, the message and the addressee are separated

from each other. Cases of that communicative mode are scarce in nature, spotting known best of all, but they have been growing increasingly important in human societies uniting separated groups of communities and even generations by providing them with the accumulated knowledge of their ancestors. Thus the *off*-line social communication is time-oriented, and both external analog and symbolic sign systems are used to code. The total sum of cultural artifacts, practices, rituals, beliefs and patterns of social behavior constitute the cooperative external social memory of humans. These signs are not "mapped" on organisms' bodies, they are invented to pass the information from inside out and extend the biological memory of humans. That extension of an individual biological memory to the social collective one provided enormous possibilities for our species development as it made it possible to store, give access to and pass on to other generations huge, practically limitless, masses of info.

Cognitive specificity *on*-line and *off*-line types of communication can be described as follows:

Biological cognitive processes are internally distributed, embodied (local) and dynamic: they are continuous and the results of mental processing are used for short-term goals – *on*-line interaction.

Social cognitive processes with humans are externally distributed, disembodied (non-local) and static: externalized results are discrete units of knowledge that are fossilized and used for long-term goals– *off*-line interaction.

Off-line communicative interaction has become decisive for human evolution [2] bringing into existence mind-sharing [8] capacities in human societies. It is this off-line communication (not necessarily including the verbal component) that demands higher forms of abstraction and easily copes with social conventions not rooted in nature. Diversification of external sign systems relevant for communal survival gave rise to the human unprecedented abstract thinking.

Conclusion

Survival of any species no matter how complex is ensured by both concrete and abstract information, and the more complex the living system the more efficiently it operates abstract models derived from the interpretation of different flows of data provided by its different subsystems. The differences in the complexity of various species biological structures of natural kingdoms can be probably described in terms of the varying levels they have in communicative competence and cognitive abilities. Cognition is distributed but so is communication. It will not be an exaggeration to say that evolution itself should be looked upon as a continuing increase in communicative competence which inevitably upgrades the interpreting abilities of the mind.

The biosemiotic approach helps to see that all forms of cognition, beginning with the biologically ingrained, are distributed as different perceptual channels of information delivery are needed to verify the in-coming data. Different forms of communicative interaction that are mapped on the organism's body demand specific cognitive structures to extract, analyze and generalize the information to adjust the body behavior to the *on*-line circumstances. The most essential data acquired through the life-term are stored for future, and each individual database is the personal knowledge of how to survive. Therefore, even in terms of spatial life spontaneity all species are dependent of different forms of mental abstraction: initial perceptual imagery (of iconic and indexical character) and generalized mental imagery stored in the memory. That lower-level mental abstraction turns out to be quite efficient for the survival of a species as closed system. The results of the internal cognitive processes are not necessarily externalized to be put to use by other organisms.

Biologically distributed environmental forms of cognition are backed up by interpersonal social forms of interaction and amplified with socially distributed cognition. Socially relevant forms of communication need convention that is why externalizing personal knowledge and adapting to collective intelligence become a prerequisite for social groups.

Off-line communication launched more generative processes in the mind that enabled combinatory links between percepts and mental images of more complex situations. It increased the capacity for *off*-line / higher-abstraction thinking. *Off*-line communication is always mediated by specific sign systems that are artificially created and are loaded with symbolic meaning – meaning that is not derived from natural existence epistemologically but is conventionally established in human societies. That social pressure led to the development of higher-order abstraction.

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