LOGOS

ELECTRONIC JOURNAL FOR PHILOSOPHY

ISSN 1211-0442

Karel Pstruzina: REM-sleep and Hypothesis

Motto: John Wisdom: ...there is no doctrine so foolish that it may not some day be able to give birth to a new and happy idea.

Abstract:

Scientists tackle a solution of scientific problems together with their experience, knowledge, methods and skills which were successful in the past and it is undeniable that these all take part on formation of conjectures and assumptions. The sleep or more precisely one of the phase of sleep (REM-sleep) undoubtedly plays the role in the process in which we create a conjectures and assumptions. We do not know all about but I claim that during the REM-sleep we probably choose from a conjectures and assumptions from which the hypothesis of the first line are emerged. Only after breaking through the barrier of observativness we can mobilize all form of thinking. I do not claim that every problem will be solved but merely that we have managed to put to use more of our own thinking equipment. There are several methods of unblocking actual thinking and bringing into play endoceptively formed structures and I claim that most profitable is the REM-sleep which still permits the preservation of the integrity of thinking. We must learn to maintain our conscious between vigilance and dream in the state which reflects our processes of thinking but still retains a single theme, and in which, if necessary, we can still by an act of will come back to the starting point of our thought.

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Keywords: REM-sleep, Creativity, Hypothesis, Thinking.

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When K.R. Popper at his treatise "On Hypotheses" engaged by the problem of creative thinking, he characterized creative or inventive thinking qua "a combination of intense interest in some problem with highly critical thinking".(1) It is of course the trait of creative thinking which finds its performance in a formation of scientific theories, but the question of the origin of scientific hypothesis remains. We have to go, for my opinion, to the mind's processes for more deepen knowledge on a rise of both the scientific hypothesis and critical thoughts. Scientists tackle a solution of scientific problems together with their experience, knowledge, methods and skills which were successful in the past and it is undeniable that these all take part on formation of conjectures and assumptions (from there the hypothesis emerges). It is not easy, of course, to scan the whole of processes by which we get the articulation of hypothesis, but it can be extremely useful for the next development of science.

I think philosophers must leave the prejudice that only voluntary and logical correct operations can lead to the ends. The thought's processes which shares on creation of a conjectures and assumptions are more abundant insofar as we could not confine the deliberated and intended processes of thinking. Many processes which are carried out in our mind can be very useful for the creation of hypotheses thoroughly they are not reflected as aware. The sleep or more precisely one of the phase of sleep (REM-sleep) undoubtedly plays also the role in the process of formation of a conjectures and assumptions. We do not know all about but I claim that during the REM-sleep we probably choose from a conjectures and assumptions from which the hypothesis of the first line are emerged.

I know that such averment have to be clarifying. First what must be done is elucidation of background from which the hypothesis can be picked out.

If we have some scientific problem then the cause of that could consist in both new facts or thoughts that has pointed out to the problem. I am here in accordance to K.R. Popper's assumption that also the new ideas and not only new empirical facts can gear scientific development(2).

The problem by this way has its base in the knowledge of scientist, in his experience, skepticism or criticism, in his ambition, the will and in the situation in science as well. But it is fuzzy determined problem. The problem have to be more precisely confined. The distinguishing between what we know and the ground of the unknowness will be established by the process of meditation. It means, the scientist goes to his experience and he scans the new facts or new ideas by the thought's operations. He ask his experience about a possibility how these new facts or ideas can dovetail with paradigms or theories which have prevailed in the mind of scientist.

Apparently, everybody as well as scientist possesses many thoughts that can be elaborated in differ levels. We have to start with explanation of new facts or ideas by the help of theories that we have accepted. A part of this work is deliberate and discursive and a part is divergent, subconscious and spontaneous. I do not want devote on the first one but second. It does not mean that I consider the voluntarily approach to the evaluation all novelties as useless. The critical and deliberate evaluation of novelties is the main stream of scientific work. The relevant logical consequences of the new theory will be always discussed by scientists in the light of existing theories. A rational and critical reassessment of the theories under influence of the new facts or ideas is not sufficient enough at anytime and they perform motive power of the progress in human knowledge. But I should like to shed light upon spontaneous and unintentional work of our mind. When I write unintentional I think that our will does not get into touch with deliberate thought's operations.

When scientist meets with new facts or ideas he fathom, compares that with his content of thinking, the theories, experience, paradigms which create the background of all processes of his thinking. This work is incessant. Scientist can go a walk and his exciting mind takes place of problems, he can read the book or speak with friends and his mind still looks for explanation of new facts, he goes to bed and his mind is not switch off the problem. But what do processes take place in his mind, how is the new hypothesis evolved?

Plato and many other philosophers have supposed that we bear all essences in our soul and that all our processes of knowledge are only processes of reminding on the time when our soul had lived among the ideas or essences.

K.R. Popper claimed that to the arising the hypothesis (or precisely to produce certain World 3 objects) is enough our ability for such production, especially linguistic one, because we learn to do things by doings things (3). It is similarly to the bootstrap theory but nothing explaining.

I think that what I called above as background of hypothesis is a thought's model of the world. I claim that all our perceptions and thought's operations that we realized are derived from such thought's model of the world which arises owning to habituation of our perception and our thought's processes. We have pre-understanding of the world which is necessary for the emerging of hypothesis and because this background is inside to our mind I call it the endocept. It is Arieti's term and I take over this one (4). K.H. Pribram uses term "neuron's model"; W. Penfield prefers term "pattern"; D.H. Hubel speaks about "coding's processes"; B. Russell calls that "scheme"; J. Fodor uses term "prototype"; and K.R. Popper "background of knowledge".

There are differences above all in the process of perception as age changes. The crucial point is, in all probability, puberty when the thalamus as a filter of sensations gets under the control of the cerebral cortex. After puberty perception is not prior to the mind, but on contrary our thinking chooses among the outer stimuli. "A child thinks as it perceives; on the contrary an adult perceives as he thinks";(5) this Vygotsky's thesis, is a summary of sophisticated processes which happen in reality in our brain.

The brain processes differ if a child or adults holds, for example, a book and perceives it. A normal adult has an abstract model of a book before his perception. This abstract model of book arises from habituation. It is by such process that we carry out abstraction from very often repeated perception. By this abstraction we can distinguish both; what is, among our percepts, invariable and essential and what general properties or features belong to the class of things. Similarly we have an abstract model of the various things which I labelled "endocepts". Though endocepts are closely related to awareness of percepts there are differences between awareness of our percepts and all sensations that our brain has recorded. We are consciously aware of only a limited amount of these percepts at any moment. Endoception is the opposite of perception. It is an inner recall of our life through the world. The endocepts is also a storage of all contents of thinking that we carry out and by which we scrutinise the world. "Beneath our conscious thoughts or perceptions there are layers of information - processing, which greatly influence what is thought or seen."(6)

But an endocept could not be identified with subconscious structure as displayed by a Freudian-type analysis. Rather it comprises large systems of past experience, images which do not currently release actions, are not easy to express in the words but are felt as dispositions to thinking.

"Most of what we `learn`, what we acquire and integrate into our personality, our self, what we make use of in action or contemplation, remains unconscious or subconscious"(7). If one adult perceive for example a book, he recalls endocept a book and his thinking all the time and spontaneously confronts endocept with the actual sensations. We can distinguish a thing only when we compare that with endocepts, with the memory of previous percepts. K. Lorenz wrote: "Information about external reality that reaches our nervous system by way of our sense organs never or only exceptionally, reaches the level of our subjective experience in its original form as separate sense date absorbed by individual receptors ... (information

travels from receptor to the mind through the process of evaluation or interpretation in some way)."(8)

Here is, for my opinion, steady ground for category of the evidence which is firmly rooted in isomorphy confirmation of percepts by the means of our endocepts. We conjecture or we make hypothesis "what it is" at every moment of our perception. And it is thinking which confirms or refuted our conjecture. Similarly wrote R.L. Gregory: "We will describe perception as a continually changing hypothesis of the world, which is tested by sensory date and stored generalizations based on past experience. We are saying that aperception of an object is similar to an hypothesis in science. It is an organization of data from many sources."(9)

Also K. Lorenz has the same view when he wrote: "Our innate perceiving apparatus is overlaid by an intellectual cultural superstructure which, much like innate cognitive mechanisms, provide us with working hypotheses that determine the course of our subsequent individual search for knowledge. ... The information on which these working hypotheses are based, however, does not derive from the store encoded in genome but from the traditions of our culture, which are far newer and coded in much more adaptable form."(10) This Lorenz's conjecture is important because he qualifies the working hypotheses to culture more than to genome. It means that our individual pass through the life is very important for our next cognition and that cultural differences play too important role in perception and perhaps in our thinking.

If R.L. Gregory and others spoke on similarities of perception to a hypothesis in science then I will focus on this problem. Thinking makes a zig-zag course between endocept and the actual sensations and confronts these actual sensations from the criterion of novelty. This zig-zag course we can imagine as picking out of endocepts from the continuously generation of chaotic network pulses especially in the frontal cortex on the one hand and modification of this network pulses under conveyed information from the sensory systems. How W. J. Freeman showed the endocept's network of pulses is more chaotic during rest than during perception. It is because we are in store for sensations, we are anticipating them but we have not certainty about concrete forms of sensations. We are perpetually changing this endocepts in confused form in the sense of generation of erratic form of pulses in network of neurons.(11)

It means, our thinking traces if something new is in our percepts. If it is not, if percepts comport with our endocept, for example of a book we do not really perceive a book but we only confirm our inner endocept by sensations which are isomorphy. It would been very troublesome for our brain to reflected a book for a long period when we have read that. Therefore our brain chooses the strategy of confirmation of our endocept of a book or we are completing that. It is perhaps tendency to stable condition of neuron model as Hopfield suppose that are a response on excitment by outer stimuli. G. Mandler labeled this process "the judgment of familiarity" and he claim that either it is no conscious effort as an immediately response to the events or we must search in our long-term memory whether it is old or new occurrence.(12) It is very similar in our quotidian life. We are living in a relatively stable environment and it would be very difficult for us to reflect the whole of our environment at every moment. But in the case that the world is some way that we do not expect it to be, of course, we perceive the world too. We are instantly giving it to the attention if something new is in our actual perception. For example, a book is damaged, or there are misprints in a book and so on. In this case our thinking reflects differences between

endocept and actual perception and we either complete, if it is possible, our endocept with novelty, or we reconstruct it, or we must form a new one.

The initiation of endocepts is not accurate to the situation but chaotic. The chaos here is more advantageous because it offers more variety of prediction of future situation. The chaos is more flexible and available and therefore more advantageous for survival. "Networks on the boundary between order and chaos may have the flexibility to adapt rapidly and successfully through the accumulation of useful variation"(14) The reason why the endocept precedes to the sensation is underlain, for my opinion, the tendency of survival. The situations that we can foresee are easier for solution from the point of view of survival. Therefore we mobilize all experience, memory, and so on, before the situation set in. Therefore we have the frontal lobes so great.

Despite of chaos at initiation of endocepts they are nearly stable. We can describe that as encapsulated. It means that when the concrete endocept is evoked the stimuli among the neurons travel on the same route. The base for the initiation of endocepts consists in repetition of situation and adequation of reaction. Such habitual reaction affects on physiology of synapses. It is the same as during learning and memory processes. The process of change in physiology of synapses could be illustrated by the figure (1).

J.C. Eccles at this connection wrote: "If synaptic growth is required for learning, there must be an increase in brain metabolism of special kind with the manufacture of proteins and other macromolecules required for increases in membranes and in chemical transmission mechanisms. The specificities would be encoded in the structure particularly in the synaptic connections of the nerve cells, which are arranged in the unimaginable complex pattern that already been formed in development."(13) The progress of changes of synapses could be described by the hypothesis of Bandry and Lynche, which is illustrated on the figure (2).

The processes of reconstruction of endocepts therefore depend on the quantity and the consequence of the inclusive novelty in the actual sensations. Sometimes new information has only a virtual character, when new stimuli are small or they are not frequent. We shift aside such information into periphery of our consciousness and they make as a latent agents. Similarly turbulent informations are not able to create a new endocept because they bring too many new stimuli, they are confused and call up a chaos. Such information we push aside to the periphery as well. These are two bounds and between them is a possibility for creation of new endocept from percepts. An persistent shuttle movement between actual sensations and endocepts which is carried out by thinking is really very similar to arising hypothesis of the first line because thought has to interpret an outer stimuli in the light of past experience. This activity is spontaneous.

Thinking is here still in the level which is, in tradition of German philosophy, labelled as "das Verstand". Thinking at this point works with the material objects and therefore it is observable or actual thinking. But thinking can work otherwise as well as with concepts. In such processes thinking does not work with sensations, percepts and images, but with ideas. The latter are most frequently externalized as words and represent a content of thinking. Therefore man can work with ideas as with things in a practical life. Man can combine or composed ideas and so he can create new ideas. Thinking is here on its own field and can evolve concepts. I think the way from actual thinking to the thinking which is working with concepts come true at five stages. The first stage involves confrontation of the sensory reaction with the habituated endocepts. The main function in this stage is differentiation of

outer stimuli. The second stage marks the registration of novelty gets reinforced and may eventually lead to restructuring the endocepts. The second stage can be said to contain the habituation acquired in the first stage. The first stage is thus raised and transformed and participates in flux of endocepts. The third stage evaluates the preceding stimuli from the vantage point of "pleasure and pain:. In other words the new stimuli need to be evaluated for us to know whether to seek or avoid them. This process gives birth to endorphines influencing in the first place the limbic system. (Thus the nervous system determines our behavior.)

The fourth stage marks the beginning of thought processes which works with ideas. These should be conceived of as neurophysiological movement in cerebral structures which, by means of abstraction, concentrate the test outer stimuli into concepts. The concepts, have property of being reflected and if need be they can be communicated in various forms of outer manifestations of thinking.

The fifth stage is concerned with the inner stimuli coming from the preceding stage. Here thoughts are put to working use, combined, interconnected in associations, analogies, etc. The endocepts may be formed and use for filtering the outer stimuli, for putting them face to face with each other and with reality and for the search for corresponding structures in reality. Thinking that can precede perception and proves itself capable of acting independently of action in the actual environment. Here observative or actual thinking is both negated and confirmed. We are in the realm of inner thinking which for purpose of getting to know the world, revealing its laws, structure and dynamics turns to itself, to experience, standard of knowledge and, mainly to the capability of cognition.

The inner thinking is a continual, never-ending process based largely on past experience which allows the creating of the new thought constructions. Inner thinking has both controlled and spontaneous manifestations. I think the spontaneous manifestation of inner thinking is nearly what I should like call "self". It is inner commentary of our live through, it is never-ending flow of "cogitationes". The most frequent spontaneous manifestation of such thinking is so called inner speech. We can also make an attempt to control inner thinking. The manifestation of controlled inner thinking is concentration. Concentration is purposeful focusing of the thought process and its fixation. The attention is fixed on single thought object or a problem and we seek arrest the spontaneous flow of thinking. This is by no means simple. Inner thinking tends to diverge, to be influenced by external or internal associations. Controlling inner thinking by means of concentration means an interrupted holding up of its flow and an unyielding effort at fixation. Another manifestation of controlled inner thinking is meditation. Here use is made of flux of thinking its continuous flow, with, however, full reflection and guidance of thoughts. The crucial aspects of inner thinking is first the confrontation of sequence of thought operations with the real world knowledge (no matter whether acquired through practice or education), to establish what is possible and what is paradoxical. In this way thinking is exposed to doubt and false paths rejected at the very start. Or certain degree of conformity with the hitherto acquired experience is sought after. Afterwards only streams filtered through this experience are passed. I claim the creation of new ideas can be described not only by the means of Hegel's negation or logical inference but also by the means of meditation where are a various generators and inhibitors of thinking can act both way; discursively and divergently.

Discursive (rationally organized) thinking is goal-directed and sequential. The goal is attained by specific, well defined process of individual operations. In contrast, divergent

thinking is only partially goal-directed. Typically, it proceeds in diverse direction and does so almost unrestrainedly because its goal is only vaguely defined and wide, one where the alternative solutions of the thinking processes can be said to compete or one which is devised so as to produce alternative answers. Discursive thinking is conscious, volitional, whereas divergent thinking is spontaneous and open ended. Discursive thinking is largely concerned with apprehending the objective reality with reflecting the objectively existing processes (cognitive thinking). Its guiding principle is accuracy. If its aim is seen as the construction of new whole, then the construction assumes the form of synthesis of individual apprehended parts. Divergent thinking, in contrast, goes beyond the facts by virtue of its spontaneity, vaguely outlined combinations are among its probable end products (constructive thinking).

Both polarities are generated or inhibited by a number of factors which affect the thought processes. Without reflecting its generators and inhibitors thinking has a limited scope. Generators and inhibitors act in both way; discursively and divergently. Well-known generators and inhibitors are: - dominance; - association; - action; - the first information; - metaphor; - analogy.

The dominance means focusing on certain operations while others are weakened. The dominance can assume various forms" an issue toward whose solution we marshal our whole thinking potential, an existing world outlook, a cultural milieu, or, conversely, a real situation in which man finds himself. Important role here could play by the type of personality and also dominance in the sense of brain hemispheres. The association brings up new interconnections, often rather remote from merit of the original operations, nevertheless revealing important new aspects of the given problem. It initiates new connections, creates new supplementary links, and takes thinking out of its stereotypes into untrodden paths. But association can mislead into blind alleys of the connectivities. Associations are distinguished according to continuity, similarity and contrast. As generators they lead thinking to new connections with the studied object and that more fully reveal it. They display it in such a way as it exist in reality. As inhibitors they are blocking the thought flow and cause the so-called looping reaction, where the impulses in the neural paths keep running in circle and cannot cross over to other interconnectivities. Another inhibiting influence manifests itself when association leads us so far away from the original thought object that thinking ceases to be concerned with it. Another source of generating and inhibiting thoughts can be found in the predominance of actions. The action generates one thought operation and block another one. Education, social relations and change in action confirm this polarity of generating and inhibiting.

The first information acts mostly on man's emotional equipment. Pleasurable phenomena reinforce and release certain operations, at the same time blocking others, sometimes more correct. The first information filtered through the emotions acts as prejudice which blocks perfectly correct arguments. Thinking thus gets impenetrably closed to any fact or reason contradiction the prejudice. The prejudice acts as one of the strongest inhibitors of thinking. To do away with some deeply-rooted, completely nonsensical prejudice has often proved impossible - both with simple-minded and high educated people. A number of studies of e.g. racial tolerance shows this clearly. However, the generating and inhibiting function of the first information on human mind can also link up with the rational side of man. This becomes evident when there is a series of problems to be solved. The thought operation differ if the first task is accomplished positively or negatively. It if leads to a positive solution, then this fact facilitates the solution of the more difficult problem. The reverse, of course, also

holds and may block adequate operations and release undesirable emotions reinforcing failure. Only after blockage has been lifted, the correct solution can be found. Negative information or failure call forth the recurrence of the same operations and continuous repetition can assume the form of vicious circle. Blocked in this way, thinking is incapable of receiving new facts or releasing other operations. Under certain conditions this may lead to mental disturbance in the form of fixed ideas. Further negative information or failure in solution often do not disturb but rather reinforce the circle. The only way out is to get hold of positive information and start generating adequate operations. Even a positive solution can act as a powerful inhibitor of subsequent thought processes. This happens where the problem offers more solutions but thinking gets stuck on the first solution turning it into an algorithm. Thinking shows a tendency to repeat algorithm even for similar problems. Thus it becomes an inhibitor, because it ceases to seek new operations which would permit an easier and more effective solution of the problem. Metaphors yield information about an object, but the specification of the object is based in advance on the participation of the subject. The similarity or transfer of meaning contained in the metaphor mobilizes the subject's resources, suggests possibility more specific interpretations. Words often fail to render the object faithfully. The uttered thoughts is already an external, fixed state of thought. Metaphors help to break through this blocking thought. Metaphors help to break through this blocking barrier and by its vagueness emphases thinking as a process shaping cognition and thought construction of reality.

Analogy assumes its function as generator and inhibitor of thinking through transferring of already known properties and relations of objects to other objects so far unknown. Analogy thus releases discursive and divergent thought processes. It acts as generator if it embraces the maximum amount of essential interconnections. In that case the apprehended reality may resonate some unreflected and not fully realized connections in the mind. It acts as inhibitor when thinking on its basis is trying to find in the object under scrutiny identical properties and relations even if they do not exist. Here analogy leads thinking astray.

The functioning of generators and inhibitors is interconnected. The inhibitor by blocking certain thought operation, makes room for others to be carry out. Thus every inhibition is simultaneously generation and vice versa. The power of generators and inhibitors varies. Beside the extreme cases of total generation or total blockage, there are partial arresting or slowing-down or even disintegration of thinking resulting in tentativeness or uncertainty. Generators and inhibitors act differently on different personality types. The functioning of generators and inhibitors is frequently subconscious. This may lead to the false conviction that thinking cannot operate differently from the way it actually does.

By the means of generators and inhibitors we can combine ideas and construct new ones. Therefore we can speak about the constructive function of thinking in this case. I suppose it is very important for scientific work because we must form, or we must construct some ideas in our heads before we uncover that in the reality of the world. We must know what we look for. Without mental construction which precedes our experimental works we cannot distinguish the facts and define them into a system. Now we can look in detail at arising of endocepts. It is important not only for perception processes and meditation but also for creativity. We know the answer on the question - what are the parts from which are endocepts founded, but how they are constituted?

My hypothesis is that the endocepts are founded above all during the rhombencephalic phase of sleep, or waking dreamlike processes, or slow-wave sleep with dream activity. Our sleep is

structured. Usually we speak about four different stages of sleep that rotates during the night four or five times. For the creativity and for elaboration of stimuli is more important the rhombencephalic phase of sleep and therefore I should like to throw attention to this phase.

The rhombencephalic phase of sleep which is very often labelled as REM-sleep is very interesting stage of our consciousness. There are serious reason for assuming that it is the stage when our brain processes elaborate and evaluate all stimuli collected from the previous two days. The neurons are immediately after stimulation inhibit to next stimuli, but the neurons have to occur the chemical changes for acceptance of new stimuli as well. These processes are sophisticated because here is important for both preparation of neurons for new work with stimuli and for sorting out of information and these processes take place during REM-sleep probably. The quantitative relation between waking and the REM-sleep state is not so simple because waking dreamlike processes can also work up the day's stimuli. "Accordingly, selective awakening by relevant (new or important) stimuli is possible during sleep after comparison of the new with old information, or automatized responses might be executed correctly during sleep without awaking."(15) For example, the pontine-geniculate-occipital spike may be recorded in nonREM-sleep or during waking.(16) Possibly, waking fantasies provide a consummatory release that reduces the same neuronal drive reduced by stage REM-sleep.

During REM-sleep we not only dream but are dreamt. We are near to meditation. The adult man dreams about 80 to 100 minutes every night, although most of dreams are forgotten. But not all dreams are visual. The REM-sleep is probably germane to memory processes. Despite of fact that in 56 studies was showed on influence rapid-wave sleep on memory and 58 others come to negative conclusions I think that REM-sleep plays important role also in memory processes. It is not only for the reason as I. Oswald showed in experiment: "if a list of nonsense words is learned, and memory is tested eight hours or twenty-four hours later, more of the list will be remembered after twenty-four hours, given an intervening period of sleep, than after eight hours without sleep. It seems that memory traces are strengthen during sleep, maybe especially by paradoxical REM-sleep; and since they presumably depend upon the durable molecules of brain protein, this can be understood."(17)

V. Bloch also produces a series of experiment on relation between the consolidation of memory and rapid EEG waves and he has posed that the consolidation of memory is required two phases of information treatment, a period of immediately following learning, and a period of rapid EEG waves without any modification of the slow-wave sleep.(18) Activity of our consciousness during REM-sleep resembles to state of aware, cortical inhibitory processes are much weaker than in the waking state and also single cell activity is at least as strong as in the waking state.(19) The brain processes are concomitanted by rapid eyes movements that give evidence about processes of thinking. Even there would seem to be kind of intrusion of waking state into dream which is often called qua dream consciousness. During REM-sleep our brain slips into a natural process in which the present-day information becomes involved with our endoceptive structure of thinking. "Dreams are thinking, mentation during sleep, the result of recall and cognitive treatment of old or recently acquired experiences."(20) In truth, many scientists are supposed that REM-sleep dreaming is linked to the treatment of information taken in and learning during the waking state. This process has probably also relation to prospective programming and the protection of the self.

K.H. Pribram described this process in this way: "When we examine EEG recording we can see that after goes back at home and put up the night the records from the whole day march

past but at reverse sequence. ... a new examining of stimuli go off from more advantageous point."(21) The importance of the REM-sleep or waking dreamlike processes or slow-wave sleep with dream activity (or perhaps other deeply relaxed processes) for the creation of endocepts consists in the necessity of restoration of ability of neurons to react on the stimuli from outward and inward of brain. Our brains are continuously working and preparing for decision making. In some way the brain is greedy for informations which want to elaborate. And when these informations are not going from outside world through the sensory systems the brain works with inner thought's content which are in brain networks stored, with imaginations, with endocepts. And these processes are not only when we are awake but also in REM-sleep. I think that these processes are foundation of our creative ability. Despite to K.R. Popper who has written: "it is a far cry from a dream to a critical creation and revision of a difficult argument"(22), I claim that REM-sleep is very important and neglected stage of consciousness, that can be useful in scientific work as well as critical evaluation. May be that a dreams are only by-products of the consciousness but more effective is for my opinion such explanation which take into consideration REM-sleep qua stage for originate of endocepts. The endocepts is every day morning either more abundant in last day experience or steady, when we were experiencing nothing new. Our consciousness immediately reflects human action and objective reality of the world but moreover there is a different part of our consciousness which has arisen in the course of long-time reflection and observation of human action. This way by which our consciousness works has been shaped by history and therefore it is the outcome not only of an ontogenetic processes (memory, experience, plans, etc. are only compononent parts of that) but a phylogenetic process as well.

All, what I hitherto claimed can enable me to construct the model of mind which could be illustrated at such scheme - figure (3). All these layers are answers to the reality of our brains or thought processes. The central position of endocepts structure of consciousness and the sleep shows not only to our quotidian life but also to the evolution which is continuing by means of scientific or cultural creativity. And it is second aspect for which I think that REM-sleep or waking dreamlike processes or slow-wave sleep with dream activity are very important phase of our life.

The creativity is most often associated with scientific discoveries and one has forgotten that there are many ideas, that can be stupid, absurd, useless, but they can be creative; the creativity can perform itself by means of imagination, day-dreams and fancy; and also in the skills in house cleaning, when one plays football or in other every day situations. These ones we can also labelled qua creative because our thinking had to overcome the familiar thought processes to new one. I do not want to tell, of course, that for example the joke which is creative has the same value as the scientific discovery or cultural movement but something what is intrinsical in our thinking is the similar.

The differences are undeniable. The scientist for his scientific discovery must work up very wide framework of facts, he must generalize many details and minute observation and he has to sort out all these facts to the coherent system. Therefore on the scientific discovery participates all knowledge, education, cultural values by which the scientist is disposed. The discovery has historical dimension and scientist must mobilize also all historical knowledge in his mind for such supreme act of creativity. (Nothing like that is in the case of creativity how one can see in football player action or other day situations.) Such elaboration of the facts which leads to the discovery is not only deliberated and fully reflected work of our mind but there is also some ulterior (or lateral) thought processes that are natural and that we do not control, notwithstanding they contribute to the successful result. It is unbelievable

mobilization all knowledge and abilities, conscious, unconscious and preconscious, long term concentration on the problem by which the scientist pass through to creation of novelty. We have not in such cases the thought processes under the consideration, most likely we only listen to our mind if we receive something original. May be that sometimes the intuition can burst in the vigil state but more often in the state of relaxation or dreams. I think that second one are more frequent seeing. In the REM-sleep or in the state of deep relaxation we do not control and do not conduct the subject of our attention, we are not intended on the problem which is only as a latent agent in our mind and therefore our thinking can bring about unusual association that never time were implemented. And this is the source of originality and the real novelty.

However man does not always employ his capability of incorporating into his thought processes actual and simultaneously also endoceptive thought structures. In every life endoceptive thinking is forced back into deeper structures by new facts comprised in actual thinking. In this way thinking gets focused on reality. This reality oriented state of thinking makes it impossible for man break through the barrier of algorithmisizing thought processes. There are many examples revealing the difficulty of defying observative thinking both in real life and man made puns and puzzles. Only after breaking through the barrier of observativness we can mobilize all form of thinking. "Our brains are at their most efficient when allowed to switch from phases of intense concentration to ones in which we exert no conscious control at all."(23) In succeeding to do so I do not claim that every problem will be solved but merely that we have managed to put to use more of our own thinking equipment. The intuition consist in our sudden seeing through reality and conceiving a new creative approach to the studied problem. Research among 230 biologists showed that with 83% of them the solution of important problems took on the form of unexpected "burst" of intuition. The intuition could be also arouse by different function of brain's hemispheres that are available by the EEG measurment.

There are several methods of unblocking actual thinking and bringing into play endoceptively formed structures and I claim that most profitable is the REM-sleep which still permits the preservation of the integrity of thinking. We must learn to maintain our conscious between vigilance and dream in the state which reflects our processes of thinking but still retains a single theme, and in which, if necessary, we can still by an act of will come back to the starting point of our thought. It is not easy to achieve. The difficulty lies in the fact that the integrity of thinking may in this phase be disturbed. Behind the shut eyes there run products of our imagination, thinking is diverted to remote association and free imagination enter in. Quite a few scientific and practical problems are known to have been solved thanks to the reflection of thinking in the REM-sleep. I.D. Mendeleyev's periodic system of elements and A. Kekule's discovery of the benzine ring are two well-known examples.

The same processes we can see also during the waking dreamlike processes because dream and waking fantasy have the similar underlying mechanisms.(24) When the hypothesis is birth many steps have to succeed, especially the critical screening of that. The same concerns to my hypothesis on the problem how does a hypothesis arises. The screening must be both by the observation and by the experimental work. And because the observation not only my own but many scientists are in consonance with thought about relation between the REM-sleep and creativity the experimental work remains. However, if we will grip this special but natural stage of our consciousness then we can unusually enlarge the capacity of our thinking. Scientific work is nowadays very demanding and we can see that this sort of

knowledge touches the limit of our mental faculties. Therefore we must mobilize all the possibilities that we have including REM-sleep, or waking dreamlike processes. Also therefore these phase of our life deserves further and meticulous investigation.

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figure 1

figure 2

figure 3

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