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European Centre for Peace and Development (ECPD) of the United Nations University for Peace

CONSCIOUSNESS

Scientific Challenge of the 21st Century

Edited by
Dejan Raković
Djuro Koruga

Belgrade 1996

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PREFACE

Consciousness is one of the oldest scientific problems, recognized already in ancient times, both in the civilizations of East and West. However, in contrast to scientific problems related to the structure of matter and physical interactions, and their implications for understanding of macroscopic and microscopic structural levels and phenomena, successfully scientifically resolved during past three centuries of explosive development of natural sciences, the problem of consciousness has remained *scientifically* unresolved to date. The reasons should be sought in extreme complexity of the phenomenon of consciousness, which required development of fundamental theories and methods, conceptually suitable for resolution of the problem.

Although consciousness has been the central theme of philosophical essays for a long time from the very beginning of philosophical thought, or traditional esoteric practices of the East and West which have reached significant level in control of altered states of consciousness with significant philosophical and religious implications - the first scientific attempts to enlighten the phenomenon of consciousness appeared only in psychology of the second half of 19th century (through development of psychophysics and theories of personality), physics of the beginning of 20th century (through development of quantum mechanics and articulation of the problem of the so called wave function reduction, and the role of observer in that process), and computer sciences of the second part of 20th century (through development of artificial intelligence and the conception that the whole cognitive process can be reduced to a computer algorithm). However, due to scientific methodological difficulties the problem of consciousness was afterwards marginalized in these sciences.

A contemporary critical survey of the problem of consciousness can be found in monographs of the eminent theoretical physicists Roger Penrose (*Shadows of the Mind: A Search for the Missing Science of Consciousness*, Oxford Univ. Press, Oxford, 1994), of the molecular biologist and Nobel Prize laureate Frensis Crick (*The Astonishing Hypothesis: The Scientific Search for the Soul*, Charles Scribner's Sons, New York, 1994), and of the eminent philosopher Sir Karl Poper and neurophysiologist and Nobel Prize laureate Sir John Eccles (*The Self and Its Brain*, Springer, Berlin, 1977).

The last decade of 20th century has been proclaimed by United Nations as the decade of brain research, which certainly gave a new impulse to investigation of the phenomenon of consciousness, as the most complex brain function. Beside the development of new experimental techniques which enabled physiological investigation of interactions of hierarchically interconnected neighboring brain's neural networks levels, the significant contribution in understanding functions of

such a hierarchical structure was given by theoretical breakthroughs in the fields of modeling of bioinformation processes and design of artificial neural networks. Neural networks, as an attempt to model the brain functioning, possess many good properties: parallel functioning, accomplishment of complicated tasks in relatively short time, distributed information, weak sensitivity to local damages, as well as possibility for learning, i.e. adaptation to environmental changes and experience-based improvement of functioning.

Beside brain's hierarchical neural networks, significant role in global distribution and memorizing (over the whole cortex) of hierarchically processed information during the learning process is played by brainwaves. Especially significant role of brainwaves is related to biophysical modeling of consciousness i.e. states of consciousness, characterized by significant acceleration of conscious information processing, which cannot be explained by purely electrochemical processes laying in the basis of synaptic processes in biological neural networks.

Therefore, in the last few years the phenomenon of consciousness comes again in the focus of the world scientific community. In 1994 two international conferences were held in USA (Tucson and San Diego), and in May 1995 a Yugoslav symposium (Belgrade) in organization of European Center for Peace and Development (ECPD) of the United Nations University for Peace - which represented initial impulse for appearance of this book. It is currently estimated that the problem of consciousness belongs to ten most significant scientific problems, although it might soon become one of the most significant owing to its potential implications in many scientific fields.

So, for instance, an understanding of the phenomenon of consciousness in *medicine* might give rise to enlightening of many secrets of the brain functioning, as well as of the role of ionic acupuncture system in cognitive aspects of altered states of consciousness. In *psychology* we could understand mechanisms and roles of altered states of consciousness in the growth of personality, control of creativity, as well as transpersonal phenomena usually accompanying these states. In *biology* it might appear that limits of interactions between individuals are more provisional than widely believed, which would be of significance not only for adaptive mechanisms on the level of the whole biological species, but even for deeper understanding of the very significance of morals in human population. An understanding of the phenomenon of consciousness in *physics* could give rise to a deeper understanding of fundamental problems of the observer's role in quantummechanical act of measurement, which would demonstrate that consciousness, space, time, and matter are more deeply interwoven than widely believed. So, an understanding and controlling of transpersonal interactions would significantly change the field of *communications*, where many traditional barriers might be radically surpassed. In *computer sciences*, an understanding of the nature of consciousness might give rise to computers with artificial consciousness, which would function on deeper quantummechanical principles. Finally, and not

accidentally, a deeper understanding of the very nature of consciousness and transpersonal phenomena might radically shift our scientific understanding of some ultimate *philosophical* and *religious* questions, traditionally remaining outside the domain of theoretical and experimental scientific methods of natural sciences, being therefore a subject of deep and painful irrational divisions throughout the whole history of human civilization, which could be finally overcome due to scientific breakthroughs in the field of consciousness.

As a result of contemporary scientific trends, here in Belgrade we have decided to unite the existing laboratory and scientific capacities of several eminent institutions of medical, psychological, and engineering profiles on multidisciplinary project "Investigation of Higher Brain Functions, with Biomedical, Technical, and Technological Applications", within the *Joint Laboratory for Cognitive Neurosciences and Neuroengineering*. The Joint Laboratory will also represent a center of excellency and scientific basis of European Center for Peace and Development (ECPD) of the United Nations University for Peace, through organization of symposiums and specialistic educational courses in the field of neurosciences and neuroengineering.

The Belgrade symposium *Consciousness: Scientific and Technological Challenge of the 21st Century*, held during 29-30 May 1995, as well as this book appearing several months later, represent first significant activities of Joint Laboratory, demonstrating competence of Belgrade scientific community to cope with so complex multidisciplinary scientific problem.

This book consists of four parts. In the first one, related to *Phenomenology of Consciousness*, after anthropological and philosophical essay devoted to archetypal selfconsciousness of paleolithic-neolithic civilization of the "divine Pelasgians" from the Balkans and its influence on Pythagoras (Lj.Kljakić), a survey of different conceptions of consciousness through history of philosophy is given, with argumentation for necessity of a new scientific synthesis (V.Abramović). Then follows a survey of investigation of consciousness in experimental psychology, with original approaches to analysis of the composition of dreams, and effects of hypoxia on cognition (P.Ognjenović), and, finally, a detailed presentation of biological bases and neurophysiological correlates of free will, attention, conscious intention and perception, and selfconsciousness and emotions (V.Desimirović).

The second part, related to *Altered States of Consciousness*, starts with a detailed comparative survey of the structure of Universe, the structure of human selfhood, human bodies, human states of consciousness, psychic powers, as well as precise techniques for expansion and attainment of higher states of consciousness in esoteric practices of ancient Indian Upanishads and teaching of the contemporary Christian mystic Daskalos, with striking correspondences between these two traditions (P.Vujičin). Then follow the application of psychotherapeutic ritual in Amazon tribal societies, with shamanistic control and interpretation of

hallucinogenic altered states of consciousness (Č.Hadži-Nikolić, B.Petković-Medved), as well as a survey of contemporary methods of neurolinguistic programming, including original integrative model for efficient hypnotherapeutic reprogramming of old behavioral models (G.Stanojević-Vitaliano).

The third part encompasses *Electroencephalographic Correlates of States of Consciousness*. It starts with a broad survey of pharmacoelectroencephalography (PEEG), i.e. electroencephalographic study of drug effects, with significant clinical implications (Ž.Martinović), and followed by a detailed relationship between clinical neurophysiological polysomnographic data and different sleep disorders (N.Ilanković, A.Ilanković). Out of the new methods of EEG signal analysis, the application of the theory of deterministic chaos is given, illustrated in the cases of normal and pathological EEG (V.Radivojević, M.Rajković, D.Timotijević, M.Car), as well as original methodology and software environment for quantitative analysis of EEG activity in altered states of consciousness, with particular application on the monitoring of the healing process (E.Jovanov).

The fourth part, *In Search for a New Paradigm*, consists of original scientific approaches to the problem of consciousness, which mostly bear characteristics of a new scientific synthesis. It starts with the conception of information physics, as a synergetic theory of classical mechanics, quantum mechanics, and theory of information, which relates consciousness with biology and physics, and finds the roots of biological form of consciousness in biophysical cytoskeletal processes (Đ.Koruga). The second approach points out a universal Mind/Matter code starting from the unity of chemical and genetic codes, unifying global-integral introspective method of the East and single-partial empirical method of the West (M.Rakočević). The original triunism concept is then presented, offering new possibilities for formulation of the scientific basis of "thought", and seeking for resolution of the brain-mind problem through relationship of three hierarchical levels: neurobiological, neurological, and behavioral ones (Lj.Rakić). Finally, a new biophysical model of altered states of consciousness is given, which - starting from the only hypothesis that consciousness is related to electromagnetic field of brainwaves, and using methodology of fundamental relativistic and quantum physics - accounts for the dynamics of psychological processes in altered states of consciousness as well as numerous bizarre transpersonal phenomena in transitional states of consciousness, necessarily implying some experimental tests of the model (D.Raković).

The Editors are grateful to all authors for their great efforts to present, in a very short time, the results of Belgrade scientific community in exploration of this extremely significant and complex scientific problem. We believe that forthcoming time will multiply repay for efforts invested.

Finally, Editors and Publisher greatly acknowledge sponsorships of Yugoslav Ministry for Development, Science and Ecology, ITM Company, and Railway Health Center Belgrade.

We are especially indebted to Branko Vukov, B.S., for his hard work and high professionalism in technical preparation of the book.

Belgrade,
May-November 1995

Dejan Raković
Djuro Koruga

ABOUT CONTRIBUTORS

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Car, M. (b. 1969, Belgrade) Bioengineer at the Institute for Mental Health, in Belgrade. Graduated with B.S. degree in computer engineering (1994) from the Faculty of Electrical Engineering in Belgrade, where he is now postgraduate student. Published several scientific papers and communications. Works in the fields of design of computer applications, digital processing of biological signals, and applications of neural networks and chaos theory in EEG signal processing.

Desimirović, V. (b. 1933, Belgrade) Professor of medical psychology and mental hygiene at the Higher Medical School in Belgrade, and psychopharmacology at postgraduate studies at the Medical Faculty in Belgrade. Formerly the Chief of Department for Psychoses at the Psychiatric Hospital in Vršac, and at the Institute of Psychiatry in KBC Zvezdara-Belgrade. Received M.D. from the Medical Faculty in Belgrade (1960), where he also completed specialization in neurology and psychiatry (1968), and got his M.S. (1976) and Ph.D. (1979) degrees in neurophysiology and psychopharmacology. During 1974 he spent one-year subspecialization in EEG and clinical neurophysiology, in Holland. Published over 70 scientific papers and communications, as well as two books, "Biological Bases of Psychiatry" (as a co-author with Prof. S.Jakulić, 1990) and "Contemporary Medical Psychology" (1994). He is currently investigating psychopharmacologically induced sister chromatide exchange.

Hadži-Nikolić, Č. (b. 1941, Valjevo) Chief of Department for Mental Health, of the Railway Health Center in Belgrade. Graduated and received M.D. degree (1966) from the Medical Faculty in Belgrade, while he completed his specialization in neuropsychiatry (1974) at the Medical Faculty in Zagreb. Got his postgraduate education in application of acupuncture for drug addiction (1978-80), in China, Hong Kong, and Thailand. Received two Ph.D. theses: first, from the United Nations Open International University for Complementary Medicine, Colombo-Athens, in Athens (1987), and second, from the Department of Ethnology of the Philosophical Faculty in Belgrade (1991). Working in the field of transcultural psychiatry, related

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and The Scientific and Medical Network. Co-founder (with Prof. R.Pešić and others) of the Institute for Research of Early Slavic Civilization. Published over 100 studies and papers in anthropology, philosophy of history, human rights, and political science, as well as several books, notably "Liberating the History I" (1993, in Serbian), and "How to Help Europe", ed. (1993, in Serbian).

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Rakić, Lj. (b. 1931, Sarajevo) Academician. Professor of physiology, biochemistry, neurobiology, and neurosciences at the Medical Faculty in Belgrade. Director of the Center for Scientific Research of the University Clinical Center in Belgrade. Received his M.D. (1955) and Ph.D. (1960) degrees from the Medical Faculty in Belgrade. Member of several national Academies of Sciences & Arts, as well as of Russian Academy of Sciences, and the New York Academy of Sciences. Founder and former Director (1967-77) of the International Laboratory for Brain Research, in Kotor. President of the Interacademic Committee for Biomedical Research of Serbian Academy of Sciences and Arts (SASA) since 1985, former Chief of the Center for Scientific Research of SASA (1990-94), former Vicepresident of European Advisory Committee for Medical Research of the World Health Organization (1984-86), visiting professor in UCLA and Baylor Univ. (USA), member of numerous international organizations and associations, laureate of Pavlov's medal for contribution in research of physiology of central nervous system, and Sechenov's medal for contribution in research of neurobiology of brain, and laureate of numerous national medals and awards. Published over 300 scientific papers and communications, as well as over ten books (five of them abroad), in neurophysiology, neurochemistry, biochemistry, immunology, and evolution of central nervous system.

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Vujičin, P. (b. 1943, Novi Sad) Free lance journalist and translator; working for many years in sales and marketing department of a computer company. Graduated English language and literature (1967) from the Faculty of Philology in Belgrade. Specialized in phonetics and taught English as a second language (1968-70) at the Institute of Foreign Languages in Belgrade. From 1970 to 1975 lived and worked in London, and completed a course in anthropology at the ILEA. In 1975 spent half a year in East Africa (Kenya, Tanzania) studying local history, culture, and politics. From 1975 to 1978 lived in Sudan. Travels extensively in the East (India, Sri Lanka, Nepal, Burma, Thailand, Malaysia, Singapore, Indonesia, Hong Kong, Japan, etc.) and West (Europe, Mexico, USA). As a frequent visitor to Indian ashrams and holy men (Sai Baba, Shivabalayogi, Niranjan, Satyananda), initiated in various Eastern practices of meditation; a pupil of the Cypriot Christian mystic Daskalos (1990-94). Writing for esoteric and New Age magazines and free lance publisher and translator of books on yoga, meditation, kabala, mysticism, chromotherapy, and psychology.

PHENOMENOLOGY OF CONSCIOUSNESS

Self-consciousness of the first civilization:
The case of the divine Pelasgians of the Balkans
(Lj.Kljakić)

The phenomenon of consciousness in philosophy
(V.Abramović)

Consciousness as a (psychological) function
(P.Ognjenović)

Biological basis of consciousness
(V.Desimirović)

SELF-CONSCIOUSNESS OF THE FIRST CIVILIZATION: THE CASE OF THE DIVINE PELASGIANS OF THE BALKANS

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The real order of things likes to conceal itself.
The invisible order is stronger than the visible.
(Heraclitus of Ephesus, known as the Dark)

All learning is a modification (or a refutation)
of some previous knowledge, and therefore,
finally, of some innate knowledge.
(Karl Popper)

Abstract: A part of the integrated corpus of present-day knowledge, especially quantum theory, has been applied here for analysis of the relationship extant between the cognitive space of possibility of Pythagoras's General theory of the Cosmos and the space of possibility of the First Civilization, a space which made this theory probable. The First Civilization and Pythagoras's theory are interpreted as monadic structures, i.e., as one-time decisions with elements of contingency which postulate new forms and symmetries, determining thus all future events in their spaces of possibility. These two monadic structures relate one to another according to the principle of the least action: in the space of the monad with the larger energy potential, the potential accumulated in the space of lower energy capacity is preserved. This enables us to identify the main patterns of both spaces of possibility. The results of analysis show that the fundamental patterns do not change. It is only their energy capacity which is transformed. Therefore, the First Civilization can be identified as the optimal manifestation of man's self-consciousness of the synergetical structure of the Universe and of man's place in this structure. The First Civilization is identified in the area of the paleolithic-neolithic civilization of the Balkans, more precisely, in the civilization whose principal localities are Lepenski Vir and Vinča. The space of possibility of this civilization was established over a period of 10,000 years. This space is the foundation and pattern of modern civilization and of its field of consciousness.

Keywords: *monad, space of possibility, consciousness - self-consciousness, universal and local symbolic field, interactive communication network, principle of least action, triangular principle of growth, integrated space-time, triple identity: light-consciousness-world, learning is remembering, double reality, wave manifestation of the cognitive capacity of civilization, First Civilization, Pythagoras.*

I

Bertrand Russell concluded that Pythagoras (c. 582-493 BC) was one of the intellectually most influential men who ever lived. Sharing that opinion, Milan Budimir pointed out the significance of the influence of the first Balkan civilization, the Pelasgian civilization, of the "divine Pelasgians" as Homer calls them, on Pythagoras's contribution to the history of mankind. Pythagoras himself, namely, was a descendant of these ancient dwellers of the Balkans.

Modern philosophy and science try to conceptualize themselves within the model of notions and methods set by Pythagoras.

Why is that so?

That is so because our Pythagoras was the first man in recorded history who integrated the intellectual tradition he found, and its empirical, intuitive and imaginative results, and presented them as a coherent General Theory of the Cosmos.

Pythagoras's theory is the result of a process of conscious reduction of all forms of manifestation of the Cosmos to a small number of basic principles. These are abstract structures which can be expressed in numbers, geometric images and symmetries of their elementary relationships. "All is ordered on the basis of the Number", Pythagoras says. That is a manifestation of individual self-consciousness of the synergetical structure of the infinitely small and the infinitely large, of the basic patterns of this structure, of man's place, role and meaning in this infinity.

This model was also the pattern for modern attempts at conceptualizing a General, Universal theory, a Theory of Everything (TOE). Present-day science is still in the continuum of possibility established by Pythagoras's model. In this connection, Russell concluded that the most surprising thing about modern science was its return to the Pythagorean. Today, science is still trying to solve the basic and universal paradox produced by the fact that every material object in the world of the senses is preceded by its ideal representation in the consciousness, by its invisible, abstract and "non-existent" archetype, by its mental image. The abstraction of shape and shape concretely manifested form a space of alternatives between two extremely remote points: between identity/existence and non-identity/non-existence. That is the continuum of the possibility of existence - non-existence. The number of possibilities set up there is infinite. The space itself is organized as space from zero to *n* dimensional.

Still, abstraction and object are only two manifestations of the same world. This is a world realized between general existence and general non-existence, on a scale from zero to *n* dimensional structure. Only consciousness is still able to integrate that infinite space and represent it in the form of an adequate model. Pythagoras was the first to do that as a philosopher and a scientist in the modern

meaning of the word. His General theory of the Cosmos represents the moment of birth of science and of philosophy in the modern sense of these ideas.

II

Over the last 2,500 years, Pythagoras's General theory of the Cosmos has had the role of theoretical archetype, of basic pattern, of monad. This is because it is the typical example of a one-time, contingent decision. It is the "third possibility", that which transforms found energy capacities (in this case, the local field of consciousness, i.e., the space of human civilization) into energy potential of a higher order.

We are thus obliged to put the question of identifying the space of possibility from which Pythagoras's corpuscular leap was possible. This space of alternative was itself, at a time X before Pythagoras, established by a previous one-time decision, by a manifestation of a previous basic pattern whose shapes and symmetries determined the future flow of events until Pythagoras and his time. It should also be kept in mind that Pythagoras's corpuscular leap does not refer to the hypothetical monad in whose space of possibility it was accomplished as an act of discontinuity with the "past", nor as an act of destruction of this "past". On the contrary.

Pythagoras's theory, as a new archetype, relates to the archetype of the space whence it came in accordance with the principle of lesser action. The principle of lesser action has universal validity. Thanks to the operation of this principle, a system (any physical or chemical system including the whole Universe) can be transformed from one energy state into another with the highest possible efficiency of work of the first order.

This is the kind of work which makes it possible to increase the potential energy of a system, without losing the potential for work accumulated in the earlier form in the process of energy growth. Also, it does not lead to entropy of the system, nor does it impair the established balance of production of energy. Pythagoras was the first thinker who saw the universal validity of this principle. Einstein thought that the principle of lesser action was the most magnificent manifestation of the Law divined by Pythagoras.

In other words, Pythagoras's theory as monad relates to the monad of the space in which it was established as the "third possibility", that is, with the highest possible efficiency of work of the first order. With Pythagoras, the potential of energy of the previous monad and its space is increased, and the energy accumulated in its "original" shape is preserved, without taking it into a state of maximum entropy. This is a relationship between two models of consciousness which was established in accordance with the universal principle of preservation and growth. The epochal importance of this contribution by one philosopher and scientist is best

confirmed by the fact that the theory which he proposed has remained preserved as archetype for over 2,500 years.

During the whole period of the past 2,500 years, we do not find any irrefutable proof, especially such which would still be available today, that Pythagoras ever publicized his theory and made it available to the contemporary intellectual community, or to those of later ages. On the contrary, there are numerous reports which say that Pythagoras did his utmost to keep the theory from spreading outside the devoted circle of his Crotonian brotherhood, as well as those which attest that he preferred oral exposition of his theory to any written text. In any case, it would seem that apart from some later reports, and numerous speculations from posterior times, none of Pythagoras's presumed works has been available for at least 2,000 years. However, his theoretical model still has the role of an ideal pattern, of an archetype of the General theory of the Cosmos.

This paradox of our intellectual history should not be cause for surprise. Let me explain.

As Pythagoras's General theory is in full accord with the universal principle of lesser action, and as it represents a possible model of optimal integration of the infinite space of the Universe and its basic principles and shapes, this means that the theory could optimally be integrated with its subject, as its nearly ideally symmetrical, abstract and symbolic interpretation. Thus, all who in any form or degree decoded the Universe and its laws after Pythagoras also decoded the intentions of Pythagoras's theory, its elements or its whole. Pythagoras's theory is thus revealed to the extent that our cognitive space, as autonomous symbolic field, is in accordance with the Universe and its shapes as its subject.

That is the "vertical" property of this theoretical archetype. Naturally, it also possesses a "horizontal" property.

As an archetype is possible only when it is in full accord with the principle of lesser action and the triangular principle of growth, this means that its content is not only a continuum of new possibilities and their energy potentials, but also the continuum of earlier possibilities, the possibilities of the space from which the corpuscular step forward was taken. In other words, the content of Pythagoras's theory as archetypal structure is integrated into itself by the accumulated energy potential of that monad and that continuum of possibility which is abandoned. The old monad and its space of possibility are preserved in the new.

These are the "vertical" and "horizontal" properties of the archetype. By ensuring these properties, creative potential is ensured, too. Namely, the new monad already contains the ideal pattern of the next one. The future monad will (not) be manifested in accord with the principle of indeterminacy.

III

Aurae Catena, the Golden or Cosmic Chain, is a symbolic, mythological or religious representation of the general human connection with the astral order of the Universe. All known symbolic, mythological, religious and mystical systems use some of the numerous forms of this idea. It is a symbol of the two-way communication channel whose mythic function is to ensure copying of the astral, celestial order into the earthly one, and, on the other hand, to enable human intervention into that order filled with supreme laws and their divine representatives.

As symbolic image, the Cosmic Chain is a sign of the coded memory of the human species of its own cosmic origin, of its place in the synergy of the Universe and of the meaning of its own role in this universal order of things.

With Pythagoras and his General theory of the Cosmos, this ancient symbolic and mythological image was transformed into the idea of a spiritual community of outstanding and wise men who were mutually linked by their knowledge of the secret of the Cosmos. Not by accident does the tradition ascribed to neo-Pythagorean and gnostic teachings of the apocryphal Hermes Trismegistus of the 1st century BC Alexandria, in its systematization of the abstract community placed in the integrated space of Cosmos and Consciousness, see in the supreme position Homer, poet of the great Balkan drama of the 2nd millennium BC. The great poet is here a personification of the celestial, cosmic, divine power of poetry, of harmony, beauty and the principle of creation. With Pythagoras, however, to whom divine attributes were also ascribed, this mythological symbolic community is definitely personified and fixed for the future of a whole epoch.

I spoke previously of the "vertical" properties of Pythagoras's theory. The Aurae Catena, the Cosmic Chain, is another name for such an individual property. In other words, whoever succeeds in articulating the model of optimal integration of the infinite space of the Universe with its basic shapes and principles, and, in this way, integrates himself with the subject of his own research, produces the Cosmic Chain and becomes a part of the celebrated imaginary brotherhood. The standard visualization of this rare event – a representation of a ladder between Heaven and Earth along which man climbs, trying to know the final secrets of the Universe – is not quite precise. Climbing up a ladder which is fixed in Earth and in Heaven as a symbol of spiritual enlightenment, of knowledge and power in general, represents a process which is actually the other way around. Knowledge is memory, and acquiring it means descent, far below the phenomenal level of our world of the senses. In any way, the Cosmic Chain is a symbolic representation of the hidden human possibilities.

During the European Renaissance, the image of the Aurae Catena was renewed with full force, on the basis of Pythagoras's General theory. Another symbolic image

had the same fate. This was the Catena Mundi, the World or Earth Chain. As the Cosmic Chain is coded information on the interactive relationship Cosmos-Man-Cosmos, thus the Earth Chain, the Catena Mundi, is a symbol of the coded memory of the human species of its common origin and of the ineradicability of its earthly and horizontal links, as well as its interactive links and communications. The Catena Mundi is also a two-way communication channel. That is the "horizontal" property of Pythagoras's theory.

If we look at these two symbolic representations as a unified whole, we recognize in them a representation – dare we say archaic? – of the interactive network established in the space defined by relations between the cosmic and the local, the earthly, the field of consciousness. At the same time, this is the image of the unity of the cognitive space which is at our disposal. This space, on Earth and in Heaven, is infinite.

We have here true complementarity of the cosmic and the local fields of consciousness. This complementarity is structured as an interactive communication network. Its symbolic representations are the Aurae Catena and the Catena Mundi.

Nikola Tesla was also acquainted with this network. This was how he explained it in 1915:

"Every living being is an engine geared to the wheelwork of the Universe. Though seemingly affected only by its immediate surrounding, the sphere of external influence extends to infinite distance. There is no constellation or nebula, no sun or planet, in all the depths of limitless space, no passing wanderer of the starry heavens, that does not exercise some control over its destiny – not in the vague and delusive sense of astrology, but in the rigid and positive meaning of physical science.

"More than this can be said. There is no thing endowed with life – from man, who is enslaving the elements, to the humblest creature – in all this world that does not sway it in turn. Whenever action is born from force, though it be infinitesimal, the cosmic balance is upset and universal motion results...

"[...] Thus, everything that exists, organic or inorganic, animated or inert, is susceptible to stimulus from the outside. There is no gap between, no break of continuity, no special and distinguishing vital agent. *The same law governs all matter, all the Universe is alive*." (Italics Lj.K.)

Pythagoras was one of the most successful voyagers through this network in recorded human history. The result of his voyage is a coherent General theory of the Cosmos, established as monad 2,500 years ago.

The monad is the point of ideal intersection of the reality of the Cosmic and the reality of the Earth chains. As ideal central order, it forms its own space of possibility between its two extremely remote and equally likely alternatives – between the alternative of its capacity becoming manifest, and that of this event not taking place. In this space, the monad determines all future events in the long range. This quality of the

monad is based on the fact that it simultaneously integrates "past", "present" and "future", in accordance with the principle of lesser action and the triangular principle of growth.

As point of ideal intersection of two realities, the monad is both realities at the same "moment". It simultaneously represents, maintains and produces two separate realities because it integrates their "past", "present" and "future" shapes. That is why the monad is simultaneously structured as

(a) symbolic field of zero dimension, i.e., as abstract world of abstract shapes, a world of Ideas, and

(b) world of multidimensional manifestation, a world of Objects.

Both basic shapes establish a space of alternatives between remote points of existence and non-existence. That is why the monad is the space of possibility established by the integration of two realities and their extreme potentials. In this way, the monad succeeds in realizing its role into the meaning of its existence: maintaining and reproducing this paradoxical structure of universal synergy. Its basic characteristic is that of integrating abstract and concrete capacities of space-time.

Pythagoras's theoretical model has this integrative characteristic. That is why this model could establish itself as monad, i.e., as the central order of the space of possibility. Naturally, this also applies to the monad which made Pythagoras's model possible. For this previous monad and its space, Pythagoras's model is a corpuscular leap in the direction of the third possibility.

IV

In accordance with the universal validity of the principle of lesser action, each new monad actually represents an act of transformation of some continuum of possibility into an energy status of a higher order. In this transformation, previously accumulated energy is preserved. Pythagoras's General theory of the Cosmos also relates to the space of possibility which it abandoned as a one-time contingent decision with the highest possible efficiency of the first order.

The "past" central order is preserved in the "present" one in the same degree in which it contains the possibility of some "future" central order. These three energy potentials represent a unified, integrated continuum: a concrete corpuscular packet of possibility and the integral space of its manifestations. This is one, which is three.

Within this space of integrated "past", "present" and "future" the space for the monadic structure of which Pythagoras's theory is the "third possibility" continues.

What can this monad and its space of alternatives be?

It can be a manifested pattern of human civilization which "immediately" demonstrates self-consciousness of the synergetical structure of the Universe, and of man's position within this structure. This monad, therefore, can only be the civilization which in real life is established as a form in ideally symmetrical relation to its basic abstract pattern. It is the point of ideal intersection of the Cosmic and Earth chains, located in both dimensions of these two realities, and thus simultaneously manifested as both Idea and Object. What differentiates it from the next monad is its lower quantum of accumulated energy potential. We should, therefore, bear in mind this duality: it is both the archetype of civilization and civilization of the archetype.

This is why it is necessary to embark on a search for this monadic structure having previously acquired a clear image of the abstract pattern, of the archetype of civilization. Bertrand Russell points out such a necessity well, when, interpreting Pythagoras, he says that a perfect triangle cannot be drawn. As an ideal abstraction, we can only see it with the "spiritual eye". This remark has general significance in the history of human consciousness, and especially in the history of science. Nikola Tesla was consistent in the application of this potential of self-consciousness. All his discoveries and inventions were placed in relations of optimal identity with abstract images (of these same discoveries and inventions) which he had shaped and seen with his "spiritual eye".

It has happened that my own "spiritual eye" has enabled me to see clearly the "perfect triangle" which cannot be drawn, in this case, the archetype of civilization as ideal, abstract pattern. Thus the identification of the civilization of the archetype became both easier and more certain.

(In this connection, cf. Fig. 1)

It remains "only" to compare the ideal abstract image with the corpus of our present-day knowledge on the history of human civilization, to found this comparative method in the results of modern science and to interpret it as a simple theoretical model.

When I recognized in a certain slice of the general history of human civilization the concrete spatio-temporal structure which coincided optimally with the image I had seen with my "spiritual eye", this was the first indicator which required that this coincidence, this synchronicity between Idea and Object be studied scrupulously.

Following numerous trails and indications, using the available corpus of our present knowledge, studying the coincidence and synchronicity perceived, I came to the conclusion that the civilization of the archetype was "hidden" in the space of the paleolithic-neolithic civilization of the Central Balkans, or its coasts and river valleys. This is the area of civilization which modern science calls Old or First

Europe. Following the intentions of the principle of lesser action, I think that it would be more adequate to call it First Civilization. This will be explained later.

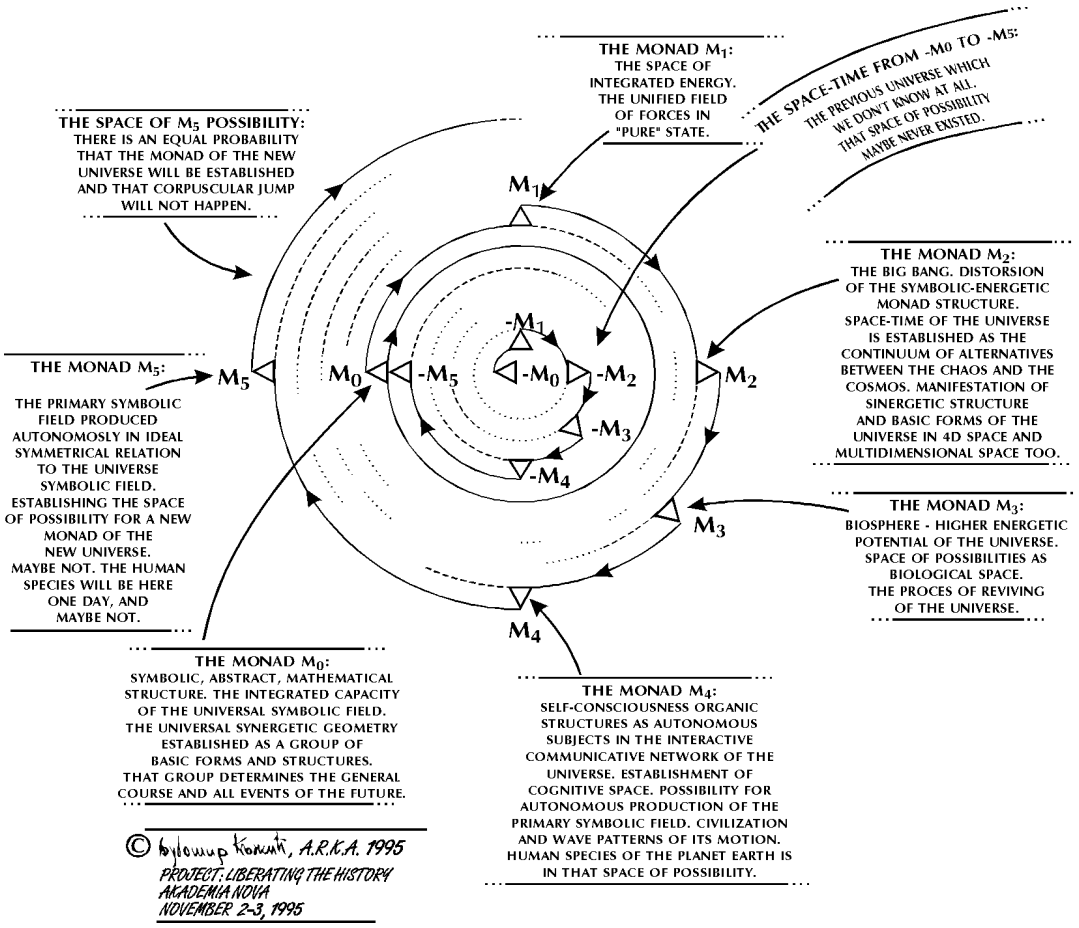

Figure 1 Abstract form of the triangular principle of growth and the principle of the least action.

V

The content of the autonomous symbolic field of this space is represented by the images of the Aurae Catena and the Catena Mundi. The great explorer of the Balkan biosphere, the anthropologist and geographer Jovan Cvijić, pointed out the fact that during the Renaissance the Balkan area was again called the Catena Mundi, the World Chain, the Earth Chain. By this naming, the space was defined in both its dimensions: as space of manifested biosphere and as autonomous symbolic field. In

both shapes this was the central space: the point of intersection of geo-biologic, climatologic and social-historic communications among three continents – Europe, Africa and Asia – and, on the other hand, the point of intersection of local interactive communication networks of these three continents. As point of intersection, as central space, this area is in constant and interactive communication with three continents through its own autonomous symbolic field. That is why it was called the Catena Mundi, the Earth Chain.

The ancient image of the Earth Chain, the Aurae Catena, was personified in the same area: Homer, Pythagoras, and so on. Personification was an act of individualization of accumulated collective experience of the protagonists of the original Balkan civilization. The act of personification could only be carried out with an image which already existed.

This standard interpretation of the Cosmic Chain says, therefore, that its earthly basis is also in the Balkans. After the gods, who represent the human link to the Universe, the first man in this series is Homer, the poet of the Balkan drama. The reason for this primacy is in his poetical opus: the integrated continuum of human and divine possibilities, of the possibilities of the Earth and of Cosmos, interpreted through the strength of the poetic imagination and its symbolic forms.

The Cosmos-Earth continuum of possibilities, a world both divine and human, was interpreted by Homer as epically dramatic tension in the space of Balkan history and its basic patterns. It is with good reason that Homer's epic interpretation was placed in the space of the autonomous symbolic field of the First Civilization and in the space of distortion and manifestation of its basic shapes. That is the Balkan-Anatolian and Apennine space. The space of these three peninsulas is the space of the establishing of the monadic structure of the First Civilization and the space of distortion of its basic shapes.

(In this connection, cf. Fig. 2)

Naturally, all the questions linked to Homer's epics are still open today: the geography of ancient Troy is as much under contention as the time of the mythic war, and even the personality of the poet is subject for debate and refutation; the only thing which is certain is that the *Illiad* and the *Odyssey* set down and codified a much older oral tradition; numerous indications speak for those theories which identify the area of the central Balkans as the birthplace of this tradition...

Several centuries after Homer, Pythagoras formulated his General theory in the same space and within the identical spiritual tradition. The difference between the two interpretations is methodological in nature. Homer sang of the reality of the universal, cosmic, symbolic field (gods and men in Heaven and on Earth, and the links between them) as of the Balkan-Anatolian reality, a locally manifested reality. On the other hand, Pythagoras reduced the reality of the locally manifested world (Balkan-Anadolian-Apennine triangle and the interactive links of this geographic

triangle with Egypt and Babylon) and integrated it into the reality of the universal, cosmic symbolic field. These two procedures are complementary, so the extravagant attempts by Ignjat Đurđević to prove that Pythagoras is actually the true author of the *Illiad* and the *Odyssey* should not surprise us.

Something else, though, has greater relevance for the main direction of this work. This is the fact that, as we have seen, one and the same geographic and cognitive space is named by two symbolic representations: the Balkans are the "point" in which both the Cosmic and the Earth chains are located. This means that in this space we can also decode the point of their ideal intersection, i.e., the monadic structure as the archetype of civilization and as civilization of the archetype.

The archetype of civilization is an information matrix which can be represented as abstract structure, as a geometrical image of the basic shapes, states, interferences and movements. The civilization of the archetype is that manifestation of the abstractly structured pattern which in four or more dimensional space whose deviation from the central order is the smallest possible. The monad is the space of integration of these two structures. The Cosmic and Earth chains are symbolic representations of such a space of possibility. In the point of their intersection lies "hidden" the monad itself.

The point of ideal intersection of the Cosmic and Earth chain for which we are looking is located in Lepenski Vir. This is the name of an inlet in the middle of the Đerdap canyon. It is located in the area of the Iron Gate, on the right bank of the Danube, between Koršo hill which rises over it on that side, and the steep cliffs of Treskavica on the left bank of the great river.

Lepenski Vir is the geographical space of the monadic structure which established that continuum of possibility from which Pythagoras took his epochal step out. This space of possibility represents the continuum of a civilization whose two basic and most influential shapes and temporal slices were named Lepenski Vir and Vinča after the initial localities of archeological identification. The Lepenski Vir-Vinča continuum covers the area of the central Balkans, the middle Danube valley and the three sea basins – Adriatic, Aegean and Black Seas – from approximately 12,000 BC to 2,000 BC, that is, about 10,000 years. This space of possibility I have called the First Civilization.

The distortion of basic patterns, shapes and interferences of the Lepenski Vir-Vinča symbolic field can be followed all over the globe. Late Ancient reports – from the 8th century on –remember this epoch as the *Golden Age*, and naming its protagonists as *Pelasts* or *Pelasgians*, or as *Divine Ancients*, as Homer said.

That is the space-time of the First Civilization and of its protagonists.

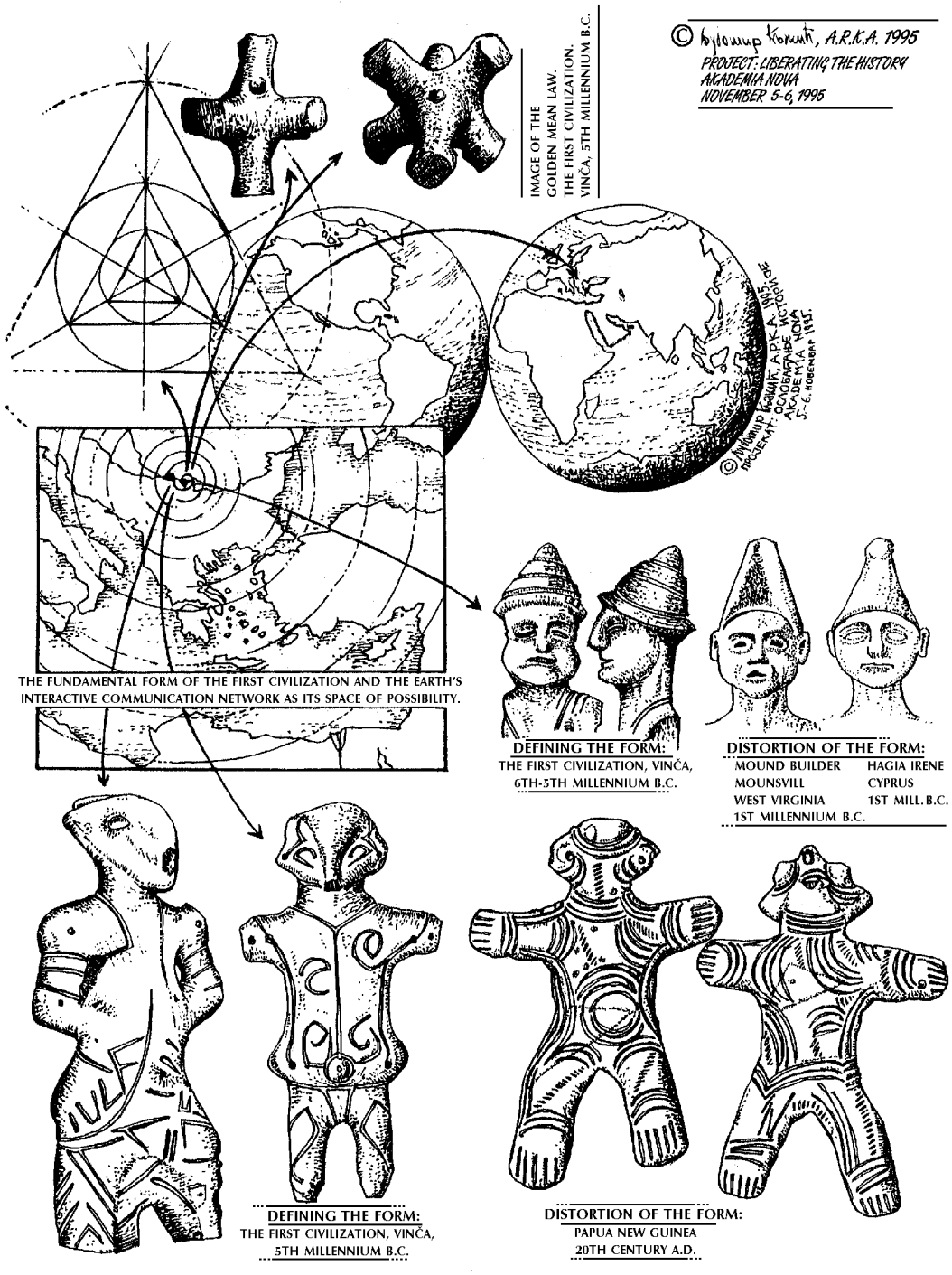

Figure 2 The First Civilization and the Earth's Interactive Communication Network.

VI

The case of Lepenski Vir is eccentric, a very peculiar case of one-time contingent decision which was produced as the "third possibility" in the space of "packing" the possibilities of human civilization, or of the planetary biosphere in general, over several hundreds of thousands of years. The time of establishment of the "original" structure of this space is lost in the period of five billion years before our time.

The rhythmical falling apart and reestablishing of the Earth's magnetic field, the movement of its magnetic and gravitational poles and rhythmical changes which these shifts brought to the planet's climate, especially with regard to the shift of the Earth's axis of gravitation relative to the Sun, changes of configuration of the continental masses and water surfaces, geophysical, geochemical and biogeochemical processes which changed the composition of the atmosphere or influenced the transformation of geological formations, the development and disappearance of numerous species of flora and fauna... etc., represent the most marked factors of profiling the space of local planetary possibilities, and therefore of its local biosphere. These are factors with a decisive influence on the forms of its transformation, as well as on the establishment of the local field of consciousness.

During the last five million years, the development of several forms of the human species and of their civilizations has been determined. These forms (Australopithecus, Homo habilis, Homo erectus, Homo sapiens) and their epochs of transformation are complemented by processes in the transformation of the total biosphere. Both currents of transformation are, namely, forms in which the same synergetic structure is manifested. It is a matter of a general process of transformation, i.e., of a continuum of transformation. It is self-regulating, on the basis of the universal validity of the principle of lesser action and of the triangular principle of growth. Therefore, in each of its autonomous and specific manifestations, on the micro and macro levels, the information matrices of the "past", "present" and "future" of the total chain of change and all its forms are integrated.

If we look at this continuum of transformation from a sufficient distance, we shall see it as a process of planetary life-giving and strengthening of the field of local consciousness. Through the history of its manifestation in the multidimensional space of the local Cosmos, our planet has traversed an extraordinarily exciting road from the status of mostly non-living to mostly living object in the interactive network of the Cosmos. With man, it has demonstrated the energy potential for autonomous production of a primary symbolic field which represents the very essence of the cosmic interactive network.

However, for this potential to be realized, it was necessary that the forms of its realization be in optimal accord with the basic shapes, states and relations through whose activity the cosmic interactive network, or universal symbolic field, is self-established.

The principle of lesser action, the triangular principle of growth and the principle of indeterminacy regulate this space of (un)successful demonstrations of the basic human potential. If we apply these principles to the presently available knowledge on total human history, and use them as methodological and analytical tools, we shall be able to define an acceptable theoretical model for reconstruction of this process.

The case of Lepenski Vir is very convenient for demonstrating this.

Standard archeological systematization suggests that most of human history had to be "invested" in painful and slow accumulation of potentials which would make the demonstration of this basic human potential optimally likely. This means that human history is "invested" in such self structuring which would make possible the relation of ideal identity between the abstract pattern of this capacity for autonomous production of the primary symbolic field and the forms in which it is manifested.

This effort was documented at the very beginning of human history.

Noam Chomsky, working within the space of cognitive possibility defined by Pythagoras, and following in the steps of Bertrand Russell, started from the conclusion on man's inborn mental capacities. On this basis, Chomsky founded his transformational-generative theory of language. This was the only way in which he could solve in the domain of language the classic problem of which he reminds us in one of his works – that serious philosophers from Plato to the present day were confused and intrigued by the question which Bertrand Russell in one of his later works (*Human Knowledge*, 1948, Lj.K.) put as, how is it that human beings, whose contact with the world is so short, personal and limited, are able to know as much as they do?

The potential of human knowledge, that is, the potential of human consciousness is a form of demonstrating the ability of the local biosphere to structure itself as an autonomous producer of the primary symbolic field in the cosmic interactive network. This potential is the basic content of the coded information in human DNA. Namely, into human DNA has been "packed" the basic information matrix of the synergetical structure of the Universe and of its basic forms: the Idea-Object relation, integrated space-time, integrated transformational continuum placed between generally non-living and generally living forms, symmetry and groups of symmetry... Self-consciousness of the contents of this package is an act of discovery of human capacities and their meaning. This is the human cognitive capacity. That is why Pythagoras, Plato and others, among them Chomsky, as we have seen, think that learning is actually remembering. The level of knowledge achieved is the level of self-consciousness of the human cognitive capacity. This capacity is coded information inscribed in the DNA and manifested in the "moment" when the first hominids appeared on the planet. This "moment" represented the first corpuscular leap, a step into the third possibility of the continuum of alternatives placed between mostly living and mostly non-living forms of the previous biosphere.

Thus, the biosphere was structured as energy potential of a higher order, as the possibility of autonomous production of a primary symbolic field. The possibility of autonomous production of a primary symbolic field is a manifestation of the potential of human consciousness to integrate the information matrix of the Universe, its synergetic structure and its forms into the total space-time of its "past", "present" and "future". In accordance with the principle of indeterminacy, the integrating power of the Universe opens up the perspective of establishing a higher energy capacity of the Universe itself.

The space of these possibilities is simultaneously "located" in the reality of the field of consciousness and in the reality of the world of the senses. These are complementary realities whose history we call the history of man, of world society, of civilization, or of (our) world.

It is simultaneously manifested both as particle and as wave, and its movement has the character of dynamic wave pattern: the matter-energy of civilization appears simultaneously as discontinuous particle and continuous field.

This is the form of structuring of information capacities of the human world in the real world of the field of consciousness, in the world of ideas and in the reality of the objects of the manifested world.

Manifesting itself both as a particle or corpuscle and as a wave or pattern of wave motion, civilization and its information capacity demonstrate basic structural identity with the structure of light. This identity is a result of the structuring of the field of consciousness itself.

Consciousness is, namely, structured the same as light: corpuscle and wave at the same time. Thus, we are dealing with the phenomenon of triple identity: light-consciousness-world, one which is three, three which are one.

This triple identity is manifested as synergetical content in every "moment" of the history of world society in which corpuscular steps into third possibilities were taken, and in which new monads were structured for new spaces of human alternatives.

Naturally, this is (also) the case with the monadic structure of the First Civilization and its space of possibility over a period of 10,000 years. On the standard time-scale of human history, this is the point in space-time which integrated "past", "present" and "future" of the universal interactive network of the Cosmic and Earth chains. The triple identity of light-consciousness-world is ideally established in this point of space-time as a new central order. Its basic forms of symmetry determine in the long run the course of all future events in the space of the alternatives it has established. Lepenski Vir has been identified as this point in space-time. The model of human self-consciousness which is structured in it represents the information matrix of human civilization as we know it today.

The integration of total space-time is the natural state of his model of self-consciousness. Information packets of universal and local fields of consciousness: fields of solar, electromagnetic, aquatic, geophysical an biochemical information wa-

ves are integrated and manifested in the civilization of Lepenski Vir as optimal potential. The community was self-consciously organized in accordance with the basic principle of optimal preservation and increase of energy, and in harmony with the triangular principle of growth. This means that the cognitive capacity of Lepenski Vir was established as the area of optimal identity between Russell's "perfect triangle" which can be seen only with the "spiritual eye" and the four-dimensional space of possibility of manifesting this ideal pattern.

"The perfect triangle" of the triangular principle of growth was used in Lepenski Vir as the basic pattern for autonomous production of the primary symbolic field. That is why the First Civilization was structured according to the rules of synergetic-energetic geometry, as this geometry of the optimal packing of spheres was called in the mid-20th century.

VII

The synergetic-energetic geometry of Lepenski Vir is the geometry of the Universe and its synergetic structure. It is the geometry of the golden mean. Its application in the space of the civilization of Lepenski Vir represents an act of self-conscious replication of the Cosmic into the Earthly transformational chain, of the astral into the terrestrial order. The application of synergetic-energetic geometry has been defined as the basic pattern of defining space-time in the localities of this civilization and in the area of distortion of its patterns. The basic form of geometry of thus structured central order is the regular equilateral triangle. This is especially manifest in the urban organization of space, in the manner of burial and in the symbolic system of communication.

The dwelling modules of the Lepenski Vir civilization were designed by the triangulation method. These are spaces defined in the shape of a regular three-sided pyramid which is simultaneously placed in both realities: it is a real object in the world of the senses optimally integrated with its ideal geometric archetype from the world of ideas. The foundation of these objects is a regular three-sided field created through a special technological process. The deceased were buried in a position whose ideal geometric shape was also a regular equilateral triangle. Symbolic systems of communication – sign alphabet, standardized visual signs on objects for everyday use – were likewise developed from the regular equilateral triangle as basic model. The signs: A, Δ, Λ have a special status in this symbolic system.

On the foundation of all these basic manifestations of the self-consciousness of the First Civilization, it is clear that this model of self-consciousness was structured as Russell's "perfect triangle". The protagonists of the First Civilization saw it clearly with their "spiritual eye". They organized the space of their own possibilities in the multidimensional world in accord with this ideal geometric form

as model. That is why the regular equilateral triangle is the basic symbol of the First Civilization in both worlds of its reality, in the reality of Ideas and in the reality of Objects.

The group of basic forms of manifestation of the triangular principle of growth of the Universe is optimally "reproduced" in the group of triangular patterns of the First Civilization . The "perfect triangle" of Lepenski Vir and the "perfect triangle" of the Universe establish an ideal synergetical structure in the space of the interactive communication network, i.e., in the reality of the world of Ideas and in the dimensions of that reality. Ideal symmetry, just like the "perfect triangle" itself, can only be seen from the coordinates of the interactive communication network, that is, with the "spiritual eye". This is the cognitive capacity of self-consciousness. We see that the capacity of self-consciousness of the men of the First Civilization was manifested as high potential of their "spiritual sight".

Although the basic patterns, abstractions of forms and relation, are *hidden* behind their manifested shapes in the multidimensional world of the senses, because the "real order of things likes to conceal itself", as Heraclitus says, it is occasionally possible to identify them. These rare moments are manifested as corpuscular, light leaps into the third possibility. They constitute new monadic structures which determine future events in the long-term and long-range. The case of the First Civilization represents a marked case of identification and use of pure basic patterns. As a civilization of pure basic patterns, it is itself an archetype, a monad of integrated space-time, its "past", "present" and "future". The waveform, corpuscular movement of the information capacities of the First Civilization represents the broadening of its field of integrated symbolically structure matrices in the "horizontal" and "vertical" space of the interactive information network. The Cosmic and Earth chains are the communication space of the First Civilization. It is the actor of the expansion and strengthening of this cognitive space.

Consequently, the First Civilization is at the same time both receiving and broadcasting station of this space: the universal and local symbolic fields are integrated in that point. The First Civilization was, therefore, in an interactive relationship with the cosmic and local – earthly – communication space. As we have seen, this is the space of dual reality – the world of Ideas, the world of Objects. In the case of the First Civilization, the capacity of its self-consciousness for active participation in the communication space of the abstraction of both realities has been determined.

This can be illustrated by the presently known manifestations of the triangular principle of growth in the area of our Solar system and on Earth itself. Regardless of whether the pyramidal structures are on Mars (the Cydonia Region, Mount Olympus, etc.) or on the Moon, whether they are the result of manifestation of a universal or local symbolic field, it is clear that we can identify the geometry of identity between these objects and the triangularly structured civilization of Lepenski Vir. In local conditions on Earth, such identification is doubtlessly easier. In this connection,

what do we learn from the relationship between the regular three-sided pyramids for the living in Lepenski Vir, pyramids "born" during the preboreal phase of the postglacial age, i.e., at the beginning of the Holocene period of the modern geological era (about 14,000 years before our time), and the regular four-sided pyramids for the dead, the construction of which began in Egypt about 5,000 years before our time? This relation speaks of the distortion of the information packets of the First Civilization, as well as of the space of manifestation of these matrices.

Numerous chronological gaps and doubts which can be caused by such a reconstruction of the interactive network on Earth and in the heavens should not discourage us. We are dealing with the phenomenon of integrated space-time and with variants of this phenomenon. Universal chronologies are based on ignoring the appearance of "slowed down" or "speeded up" flow of time in general, and of the time of local spaces in particular. A good example for this are the contemporary paleolithic-neolithic civilizations in Papua-New Guinea. Even in the 1990s, figurines are still in use in Papua-New Guinea which are identical to those from the epoch of the Balkan Vinča, dated to the 6th-3rd millennium BC. Be that as it may, comparative analysis of "natural" and "artificial" objects of known space-time on Earth and in the heavens enables us to identify the interactive communication network and the place of the First Civilization in it.

In Pythagoras's classification of the basic geometric shapes and objects, in a classification for which we have to thank the preserved writings of Plato, the triangle is the fundamental pattern, and the tetrahedron, a regular three-sided pyramid, is the symbol of fire, that is of light, that is of consciousness. Modern quantum theory explains the space of possibility of manifestation of some space as a continuum of alternatives between "yes" and "no". The infinite number of combinations of two basic and extremely remote alternative points is not structured as matter, but as a space of corpuscular, that is light, information waves on possible energy manifestations. The act of each manifestation represents a step into the third possibility. In order for something to be manifested in the relation between point A and point B of some space, it must broaden this space by establishing point C. The establishing of point C is the corpuscular or light leap. The geometry of Lepenski Vir is the manifestation of such a leap. It is a manifestation of light, which means of consciousness. The regular equilateral triangle and the tetrahedron, a regular three-sided pyramid, are the basic patterns, shapes and symbols of such a central order. For Pythagoras and his followers, the center of the Universe is occupied by fire, that is light, that is, consciousness. The symbol of the center of the Cosmos is a regular three-sided pyramid, a tetrahedron. For present-day science, this structure is the triangular principle of growth manifested as corpuscular space of alternatives and of the light step into the third possibility.

In any case, the symbolic languages of the first and of present day science identify identical basic shapes in both members of the synergetic structure

interpreted here: the regular equilateral triangle and the tetrahedron in Lepenski Vir and in the "beginning" of universal space-time of our Cosmos (cf. Fig. 3).

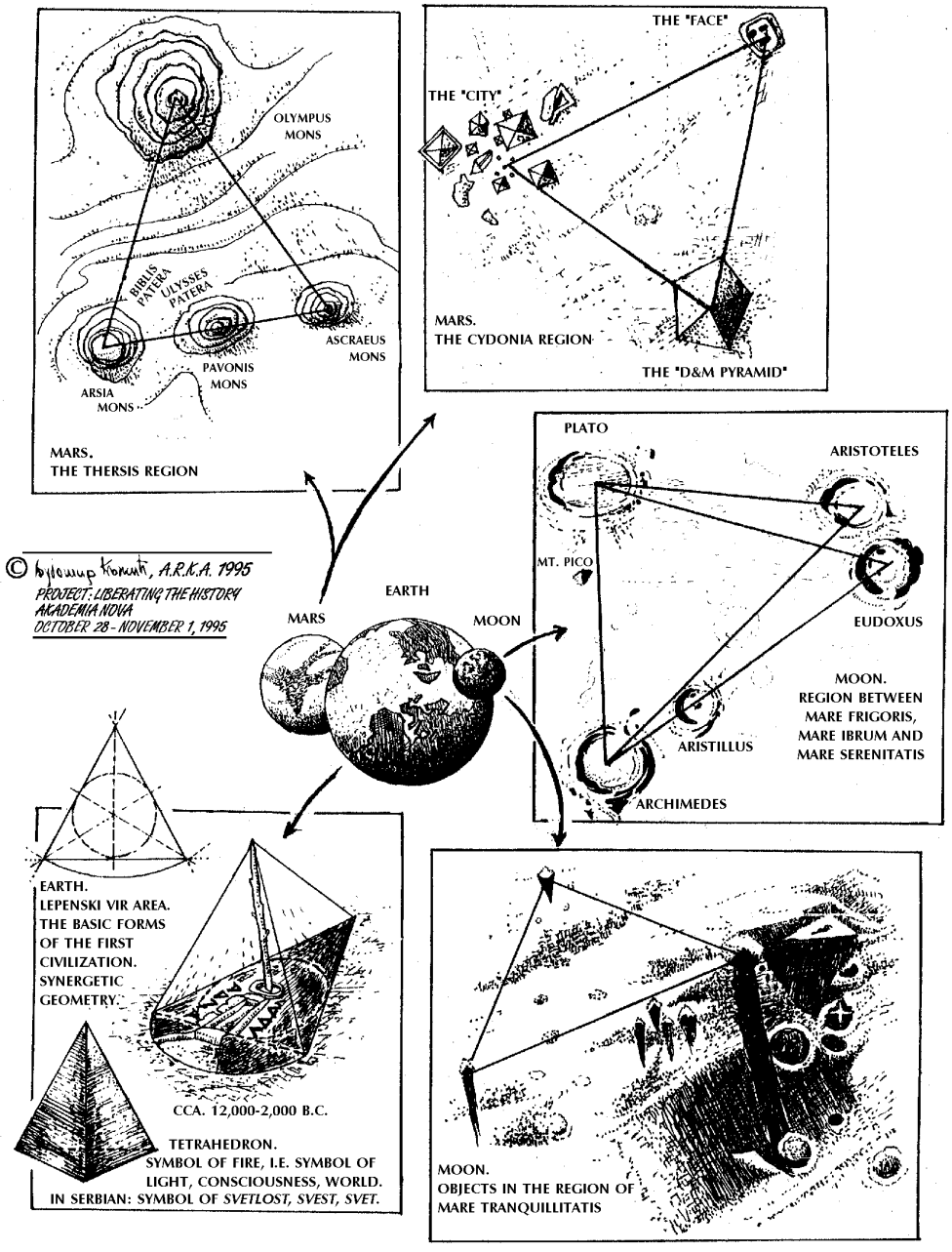

Figure 3 A few examples of Triangular Structures in the Local Interactive Network of our Solar System.

Maybe this is the hidden meaning of the story of a certain "barbarian" reported to us by Plutarch in the 1st century AD.

It deals with the "barbarian's" geometrical abstraction of the Universe, based on a total of 183 worlds. They are disposed in a regular equilateral triangle with sixty worlds on each side, while the remaining three worlds were placed at each of the apices. The worlds touch each other slightly, and, at the same time, move all together, "circling as if in a dance". The inner surface of this triangle is the "common hearth of all the worlds". It is called the Field of Truth. In this universal Field of Truth "immobile lie the principles, shapes and causes of all that has been and all that will be, and they are surrounded by eternity which seems to be flowing away as if rushing towards the worlds".

This late neo-Pythagorean image from the 1st century AD is basically not different from the interpretive model of modern quantum physics. From the standpoint of present-day science, the Field of Truth represents a one-time contingent decision – a monad, or archetype – which establishes new shapes and symmetries and thus defines in the long term the next cycle of events, until the fulfillment of its energy optimum and its transformation into the next monadic structure and its space of possibility. As a beautiful example of a contingent one-time decision in human history, our Lepenski Vir itself represents a Field of Truth, that is, a group of basic patterns and symmetries which determine the future flow of events. The probability of Pythagoras's General theory of the Cosmos was established in its Field of Truth.

It is with good reason that later Ancient sources remember the First Civilization and its Field of Truth as the Golden Age of the human species. It is understandable that the protagonists of this civilization enjoy a high reputation. They are remembered as the Ancients of the Balkans, or the Pelasgians, as Hellenic archives transcribed their name, and as history up to our time has written.

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The theoretical model here interpreted enables us to define the cognitive strategy of learning as memory of both scales of the interactive communication network. That model is an abstract pattern for integrating total space-time and its "past", "present" and "future". This close packing of spheres is optimally possible in the space of synergetic-energetic geometry. The manifestation of this optimum is a form of demonstration of human self-consciousness. On the example of the closely packed spheres of Pythagoras's General theory of the Cosmos and on the model of self-consciousness of the First Civilization, the analytical and integrative possibilities of this model have been demonstrated. It is the result of synergetic structuring of the knowledge available today. It has been shown, however, that

"ancient" knowledge does not differ significantly from what we call modern science and philosophy. Basically, this difference cannot be established, because both cognitive corpuses refer to the identical synergetic structure of the infinitely large and infinitely small Universe: both are manifestations of the same field of human possibilities. The space of possibility of civilization as we know it today was established by the structure of the First Civilization – Lepenski Vir-Vinča.

From the "moment" of manifestation of the monadic structure of the First Civilization, we can reconstruct the basic pattern and space of distortion of its field of consciousness. The theoretical model used also makes possible to determine the place of the First Civilization in the universal interactive network, that is, its total integrative potential.

The First Civilization is manifested as a process of optimal "reproduction" of the basic forms of synergy of the Universe in the local order on Earth. That is why its space of possibility is still active. Through history, we can follow the process of growth of this energy capacity, but also the processes of its fragmentation, individualization and removal from the original central order. It is a fact, however, that this energy capacity is still defined in the long term by the basic patterns and symmetries established by the monad of the First Civilization. This is demonstrated by Pythagoras's theory. Monadically structured, this theory is a manifestation of the optimal potential of individualized human self-consciousness within the space of possibility of the First Civilization. Pythagoras's model is an act of energy growth of this space.

Finally, it should be pointed out that the model applied here has shown the productive dimensions of the attempt to integrate, and apply integrally, the scientific knowledge and potentials of individual self-consciousness. This is the road to the foundation of a new paradigm, of a new theoretical model.

This perspective of close packing of the cognitive spheres of various scientific disciplines into one synergetic structure returns us, however, to the very beginning of scientific and philosophical thought. Indeed, the model of original unity of science and philosophy can be established today as the optimal potential of the accumulated energy of the total planetary field of consciousness.

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THE PHENOMENON OF CONSCIOUSNESS IN PHILOSOPHY

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Abstract. In this paper a brief survey of the mind conception in the history of philosophy is given. It is also noted that psychology should be ontologically based on the principles and definitions of physics, and that necessary United Science is to be formed of ontology, geometry, arithmetics, physics, and psychology. It is to be achieved by the proposed new categorial system of the United Science, which consists of sixteen elementary concepts in univoque correspodence.

Keywords: *consciousness, phylosophical survey, ontology, categorial system, continuity, continuum, discontinuity, discontinuum, Universal Consciousness.*

However persistent philosophers were in their attempts to scientifically separate the spirit from the matter, their attempts have, as yet, failed. The reason for this failure is that such a separation would also suppose a change of the fundamental philosophical doctrine and sentiment saying that the world exists as a unique, isotropic and onekinded infinity, in one word - an entirety.

In the history of philosophy, the definitions of consciousness have generally been descriptive, naive or negative. Often has only a basis of the power of perception, cognition and recurrent communication been determined, including intelligence and understanding. And however philosophers attempted to determine the notion of consciousness distinctively in relation to the contents of other ontological notions such as, for example, existence, being, non-being, essence, continuance, time, space, matter and energy - their efforts have failed.

Let us remind ourselves to some concepts of the spirit, cosmic mind and individual consciousness, especially from the ancient Greek period, the concepts that are still impelling to our contemplation.

Men have always been amazed before the phenomena of consciousness and awareness. They conceived that it was impossible to see through the reality of the world and explain its origin, without taking a distance from one's own existence. As such a distance cannot be established by human contemplation, religiosity was introduced: transcendental relation with the other and the unperceptible. Actually, in their contemplation, philosophers arrived to the ultimate point of entire contemplation and logic as it is - they arrived to infinity, that had to be understood as always present, the genesis of which could not have been understood by contemplation. That real infinity of ancient philosophers, represented, in a logical

sense, the border notion or pure a-formal contents, that is, the *fundumentum relationis*, with the field of religious insights vaguely behind it. And, just like inductive and deductive paths in logic separated very early, even before Aristotle realized them, thus in contemplative wisdom of Far East nations, as well as in the roots of Western tradition - Ancient Egypt and Ancient Greece - materialism and spiritualism, some would say idealism, were separated. In the very essence, these were two types of thought, one of which started from experience, and the other from an abstract idea, actually from nonspatial laws, or better said, from operations with ultimate parts of the supposed infinite being. Human mind found all this more and more difficult to bear with, especially when the world of scientific facts and educational system established their truths and cannons. In the Middle Ages, a professor became an ex cathedra state. He had at his disposal a diploma as authority and passed on to his students only proven and confirmed truths. At that time, consciousness was identified with the biblical answer of God to Moses in the tent. To Moses's question: "Who are you?", God replied "I am". These simple words contain all the impotence of human mind in realizing: "Where did the World come from?". The reason for creation is not even mentioned.

The Pythagoreans, Socrates, Plato and Aristotle attempted to overcome the materialistic understanding of the mind as the one that collects, organizes and understands sensual impressions. As all of them knew the nature of mathematics, they identified mathematical operations with the essence of human soul and cosmic spirit and found out that the soul is of nonmaterial character. Of course, something like this could have been proven exclusively by a negative definition of spirit and soul in relation to the actual world and physical functions and characteristics. The Pythagoreans introduced the notion of embodiment of the soul, in relation to Homer's notion of thymus, the breath of life. They thought that life had a completed circular sense, as the number of times each man inhales and exhales in the course of his lifetime is even. *Psyche*, for Homer, although he frequently used the term as a synonym for *thymus*, was only a sign of the life's principle, and not a pure life's principle, as it was later for the authors: Parmenides, Empedocles, Democritus, Plato and Aristotle. Homer worked out a theory of posthumous similarity of soul with the body it was separated from, thus becoming a precursor of modern spiritualism. *Nus*, the cosmic mind gifted with understanding, hence, reason, is another of Homer's contributions to the contemporary understanding of intelligence as a pattern of awareness of logical ideas. The problem Homer had in representing contemplative relations differently than the objects of logical thought, has remained to this day the main problem of the relation of rule and matter, that is, idealism and materialism. This is to say that numbers may have materialistic interpretation and can be attached to things, but numerical operations can in no way be represented in spatial and materialistic phenomena. The solution to the space-time structure of the matter can already be found here, in the same manner as mathematics expresses it: numbers are space, and numerical operations are time.

Let us go back to the Pythagorean doctrine of soul incorporation, to the 5th century BC. According to Pythagoras, the soul is nothing else than a number, some kind of a characteristic principle of structuring spatial entities, that is extensions. As the numbers have also been "spatialized", this Pythagorean theory of the soul is actually the only possible solution to the synthesis of soul and matter.

According to Democritus, the souls are atoms of fire, and at this point, he agrees with alchemists, esoterists, hermetists and spiritualists of the 19th century who held that all matter had a soul, that is the soul is inner light of any phenomenon. Such light emanations of the soul have been noted, according to witnesses, in many spiritual sessions and it can be said that spiritualists essentially followed the materialistic explanation of a spiritual substance. The substantiality of the soul is in its unchangebility at the moment of death, that is its discarnation from the somatic environment.

Anaxagoras, who did not follow the materialistic concept of the soul, held that Nus, the mind, is the most worked out of all things, as well as the purest one. He sharply differentiated the conglomeration of raw matter from the spiritual substance, that is the principle of movement and order, the principles he thought were the main attributes of the life principle in general.

Heraclitus compared the soul to fire and infinite movement, claiming that processes in the matter are caused by fire. According to him, we are the flames, and our bodies are processes. Heraclitus' cosmology teaches about infinite movement and all material things being in an internal flow, ruled by *logos*. He held that the borders of the soul cannot be found, as the movement of the universum cannot be stopped.

In the medical essay *On Sacred Illness*, Hypocritus concludes that, of all the organs, brain is closest to the nature of soul. The brain rules over limbs, it is the carrier of conscious orders and informs us on what is happening in the outside world. Hypocritus speaks of the soul as of air that offers intelligence, commenting, however, that air that a man breathes reaches the brain before all other organs.

In his work *On the Nature of Things*, Lucretius adopts Heraclitus' and Democritus' views, claiming that nature is composed of the smallest of atoms, atoms of fire. He sets out a topologic hypothesis of the soul structure, that is, in its essence, dualistic. The soul is in two parts, the rational part being in the heart, and the emotional being dispersed all over the body.

There is no doubt that the issue of the soul structure has been one of the main problems in the history of philosophy and that the most abstract answers had been given at the earliest stage. Pythagoras' claim that numbers and their harmonic relations actually precede the birth of man and outlive the body, is the one that we would still respect in contemporary neurology and biophysics, as the model consideration of that problem. Quantum physics and relativistic theory have shown

that, although matter changes and energy converts, although there are different theories on the appearance of space under the influence of force, something substantial still remains, something that is not related to movement and relativistic temporal changes. This can only be the body tissue, the very entity of infinity, or how we usually call it, the continuum. In Pythagoras' time, there was also a model of a *double soul*, that anticipated the existence of an immortal soul of a higher type and another soul of a lower type that is prone to decline. The harmonic relation of these souls provides for permanence and the disharmony makes the transition to death. In Plato's dialogue *Thimeus*, we find that the shaped human body, a living being in general, as well as still matter, is a result of the influence of idea, that is, pre-existing form that "impresses" itself into the shapeless and infinite space. This is directly related at Aristotle's notion of the primal matter. The nature of the shape is in a numerical relation and its basic spatial correlate is a triangle. This leads to the conclusion that bodily organization is a consequence of the harmony of numbers that precedes material creation. This has been followed later by neoplatonists, Saint Augustin, Greek patristics, and even Descartes himself.

For Plato, the soul is neither the form nor the idea in itself, but has been joined to forms and ideas. This shows that Plato also attributed some kind of a material basis to the soul. In any case, Plato, just like Aristotle, held that the soul is the essence of the living body. Aristotle describes the soul as the first entelechia. While for Plato, the World is God's work, Aristotle claims that the World is created by parthenogenesis, self-development towards a certain objective and that this development will at one point end. Anyway, the Orphic-Pythagorean tradition saw the body as imprisoning the soul, transforming shape through transmigration. Socrates and Plato held that the soul was also governing the body and noted the interaction of matter and spirit. This idea was later further developed by Sigmund Freud, who saw it as a spiritual-somatic conflict, the so-called spiritual battle with somatic consequences affected by psychoanalysis. This was later developed into a comprehensive philosophy of reality ethics: the problems of the body influence the soul, and the soul changes its ethical principles, will and pattern of individual and social consciousness.

Saint Augustin held that consciousness and mind were nonphysical. Accepting that the essence of the matter is extension, Descartes deduced the premise that consciousness and soul are non-spatial. For Leibnitz, this led to equalizing the soul with nonextensible Euclid's points, monads. In order to separate the spirit from the matter, Descartes introduced *the thinking substance*, *res cogitans*.

In contemporary psychological theories, a hypothesis of the social structure and defining the soul was being skillfully avoided. The silent consent has been to accept this unclear notion, and consider exclusively visible manifestations of the activities of the soul, for which no one knew what they actually were.

In their works in physics, Newton, Bošković and Maxwell introduced a completely new line of understanding the spiritual entity, studying cosmology, power, ether and light. It became evident that there is a ladder of existence of the very matter itself and that it can be differentiated by its finesse. Therefore, for Newton, matter can be subtle (light) and gross (solid bodies). Bošković spiritualized the concept of matter's structure by claiming that it consisted of a finite number of non-extendible centres of attractive-repulsive forces. He ascribed spatiality to force, and represented matter as being non-spatial, hence agreeing with Descartes and his *thinking substance*, that cannot be found anywhere in space, but is still acting. Maxwell, identifying Newton's omnipresent gravitation with the subtle ponderabile matter called ether, united the electromagnetic with optical phenomena. In the mid-nineteenth century, Sir William Crookes, an English scientist who researched psychic phenomena, recorded illuminate emanations of dead people's souls, thus opening the path to the experimental psychology of a higher order.

Out of all contemporary theories discussing the structure of the human soul in general, reducing it to physical and biophysical explanation, definitely the most successful one is the theory of the distinguished Yugoslav biophysicist D. Raković, who introduced an ontologically based and experimentally verifiable theory, claiming that consciousness is an electromagnetic component of brainwaves' ionic currents, generated by the human brain in the course of its functioning. This theory was followed by a premise that the soul is an inherent property of electromagnetic fields of composite characteristics. As a supposition linking physics and philosophy with psychology and biology, this hypothesis of consciousness opens up the way for humanizing electronic technologies and telecommunications, that are nothing else than imitations of man's cerebral centres.

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If we are reminded of the only reasonable stand claiming that the world is a united entity, and in essence, really infinite, we as researchers arrive to the main question: Why are there few sciences researching the same issue and how is it that the natural continuum, being of one kind and homogenous, has never been uniformly defined? This is the question of establishing a united science, philosophy of all other philosophies, i.e. establishing a fundamental relation between ontology, geometry, arithmetic, physics and psychology.

Let us remain in the realm of psychology. In defining psychological phenomena, we shall begin from two statements of Albert Einstein, that can be accepted as they are: (a) "Physics is an ontological science, the science of the essence of the world"; (b) "There are no non-physical elements in the activities of the human brain".

On these grounds, it is possible to construct an ontological basis for uniting the primary notions of the following, apparently separated disciplines: theoretic biology, biophysics, psychology and neurology. The greatest effort of the mind is in putting the principal scientific notions in accordance with the coincidence of its contents, so that one law rules over all disciplines, and the forms that it produces, empirically different, can be predicted.

Let us suppose that the key points in ontology are: continuity, continuum, discontinuity and discontinuum; in geometry: point, line, angle and volume; in arithmetic: zero, number, algorithm (mathematical operations), the unit of production, i.e. sum of undividable units; in physics: universal time (simultaneity), space, succession (the order of non-unitemporal events), matter (particles which create the structure in a temporal relation); in psychology: cosmic consciousness (non-spatial, pure time), cosmic soul (spatial, *anima mundi*), psyche (individual soul, the principle of organizing electromagnetic entities, characteristic vibration code), somatic structure (level of electromagnetic waves, subatomic level, atomic, molecular and higher organization).

It seems as if the uniform correspondence of notions in the above mentioned sciences has led to creating an ultimate philosophy for natural and humanistic disciplines. In that way, the age old dream of all cosmologists, philosophers and religious scholars would come true, and would enable strong penetration and fast progress of contemporary thought. In case ontology, geometry, arithmetic, physics and psychology fail to connect into one philosophical system, there will be a disharmonic development of various disciplines and thought in general. We can already feel the consequences of such dysfunctional development in relation to cosmic environment on the planet Earth, as a vast obstacle to the survival of civilization. The agreement of human individual with mankind, our planet, the Solar system, galaxy and Cosmos, has its roots in the discovery of a fundamental relation of spirit and matter. This relation must become an object of a positive science, if we do not want science to degenerate into experiments of technological power with unforeseen mistakes. In other words, mathematics, physics and psychology, understood in the widest sense, must be ontologically based as one science.

Let us take continuity as the first notion of ontology and look at which notions it corresponds with in other sciences. Continuity is uninterruptence, the principal characteristics of continuum without which continuum could not be uninterrupted. In geometry, continuity is correspondent to the notion of the point, *that which has no parts*. In arithmetic, continuity corresponds to zero, in the quantitative sense to something that is infinitely small that is, therefore, not a quantity - but lack of quantity. In physics, continuity is an ontological notion corresponding to universal time or simultaneity. In psychology, continuity is cosmic consciousness, simultaneity of all activities, i.e. the principal characteristics of infinity. And just like the point in geometry seamlessly connects consequent numbers in a series, non-spatial cosmic consciousness is nothing else than an order of simultaneous events or something

that, however non-spatial, enables the presence of space, in our case - infinity, and that is universal time or simultaneity of all parts of an infinite being.

For another notion of ontology, we would discuss continuum, that corresponds to space, in contrast to the previous notion, continuity, that is corresponding to time. In geometry, continuum is defined as a line (length without width, pure dimension). As such a line has no preferred direction, it determines the sphere, and according to the spherical law, becoming its diameter. It is obvious that parts of the being are necessarily spherical in form. In arithmetic, continuum is nothing more than the Number, arbitrary quantity, always finite, but with neither the lower nor the upper border. In physics, continuum is an ontological notion for diffusion, space as such. In psychology, continuum is a cosmic soul or *anima mundi*, material basis of which is pure spatiality. This spatiality is a constituent of any individual soul that, apart from extensivity, also has a corresponding number, or a rule of order for parts it is made of.

The third notion of ontology is discontinuity. The role of discontinuity is to disconect the very being so that its parts can be separated, discontinued. If this being is of same kind and infinite, then it is uncessational. A part, of the same composition as the being itself, cannot stop it. Hence, where does our experience of the discontinuity come from and how do parts of the Being become independent in the global entirety? Discontinuity in geometry is related to the angle (two lines meet at the top creating discontinuity, ending the monotoneity of the Being). Arithmetically, discontinuity is caused by mathematical operations with numbers, changing the density of the mathematical continuum, as the appearance of a geometric continuum (the angle is already a surface, a plane), introducing succession into physical events, that is the order of non-unitemporality. In psychology, discontinuity is the number expressing the law of order of electromagnetic entities entering the contents of an individual psyche, i.e. vibration code of any individual soul. The soul has its temporal segment or consciousness and its spatial segment or illuminate entity. In conclusion, geometrically, discontinuity is an angle, arithmetically, it is an algorithm, physically it is succession, and psychologically - harmonic vibration ordering the electromagnetic level of what we call nervous system. From this level, commanding and programming of subatomic, atomic, molecular and more complex levels takes place. We should call this operation of the spirit over matter - "engineering of a hidden state".

The fourth notion of ontology is discontinuum, in other words what is created with discontinuity as structural and material consequence of its very creation. In geometry, it corresponds to the volume, a separated and completely limited part of the continuum. However, its constraint in space does not detach it from the entirety of the Being, as the borders of the planes' volumes are without breadth and lines are without width, seamlessly joining the outer world of the continuum and inner world of volume. In arithmetic, discontinuum is made of units of arbitrary quantities, corresponding to arbitrary dimensions of volume in geometry. When an ontological

notion of discontinuum is introduced into physics, we find out that it corresponds to the structured matter, something that already has its inner and outer space and acts as an autonomous system. It is the question of subatomic, atomic and other structures being created out of spherical parts of the continuum, that is, in a physical sense, out of basic structural units of matter. In psychology, discontinuum is an ontological notion for somatic structure, that is a phenomenon with the highest and most complex organization, that in relation to other phenomena, has its vertical of existence and functions as a system that is selfmaintained by cyclic energetic exchange with the environment.

The above categorial system of the proposed united science is summarized in Table 1.

All the above mentioned conclusions have been based on one supposition only, and that is that the world is a real infinity or physical continuum, with temporal characteristics, i.e. characteristics of continuity. This is to say that consciousness is the same as time and the entire infinity in the spatial sense would certainly not exist, if all its parts had not been subjected to the same temporal coordinate, i.e. if all of them had not been simultaneous. In regard to cosmic psychology, that is not limited to individual souls and final phenomena of living beings and things only, this would mean that universal time is a cosmic consciousness of infinite space, or as Leibnitz and many other profound scholars say: *All Universe is alive*.

Table 1. *Categorial system of United Science (univoque correspondence from left to right)*

ONTOLOGY	GEOMETRY	ARITHMETIC	PHYSICS	PSYCHOLOGY
Continuity	Point	Zero	Simultaneity (Universal time)	Cosmic Consciousness (Non-spatial, pure time)
Continuum	Line	Number	Space	Cosmic Soul (Spatial, Anima Mundi)
Discontinuity	Angle	Algorithm (Mathematical operations)	Succession (The order of non-unitemporal events)	Psyche (Individual soul, the principle of organizing electromagnetic entities, characteristic vibration code)
Discontinuum	Volume	The Unit of Production (The finite sum of undividable units)	Matter (Particles which create the structure in a temporal relation)	Somatic Structure (Level of electromagnetic waves, subatomic level, atom, molecular and higher organization)

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CONSCIOUSNESS AS A (PSYCHOLOGICAL) FUNCTION

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Abstract. Although a traditional topic, the problem of consciousness was neglected in psychology for decades. This was due to strong influence of behaviorism and increasing requirements for the objective approach to psychological phenomena. However, in the last few decades, research on consciousness has received a number of impulses from surgery (commissurotomy) and from the research on neural networks. In experimental psychology the problem of consciousness is indirectly addressed through the Information Processing approach which is to a certain extent a continuation of the research initiated by Binet and the Würzburg school. This study is a brief summary of thirty years of experimental research in which we investigated consciousness. The research is primarily focused on the effects of hypoxia on cognition and the analysis of composition of dreams. From the perspective of our research, consciousness is a composition of distinct cognitive processes of different phylogenetic age. It consists of several levels of decision making. Surface processing levels enable fast reactivity, with more realistic (detailed) representation of external reality. As the decision level becomes deeper, the picture of reality becomes less veridical and less durable, but allowes for dynamic increase. The purpose of decisions being displaced towards more deeper levels, which arose during the evolution, is to enable a higher degree of freedom, i.e. a choice among a larger number of alternatives.

Keywords: *consciousness, psychological review, hypoxia, cognition, dreams.*

Consciousness is a traditional topic in psychology. A hundred years ago, at the time when psychology was formed as a science, it was consciousness that was its fundamental subject. Therefore it sounds paradoxical that contemporary psychologists, who outnumber nineteenth-century psychologists by the thousands, deal with this subject in a considerably smaller degree. In some branches of psychology this topic is hardly mentioned, in others it is not mentioned at all. So one gains the impression that for a considerable number of psychologists, consciousness is too big and too venturous a task, and that for this reason the predominant tactics is simply to avoid it.

There are, of course, strong historical reasons for such attitudes. We should remember that the problem of consciousness is not only a traditional topic in psychology, but also in philosophy. In philosophy it has been dealt with for several millenniums. This fact hides the reason for great caution of scientists regarding this subject. For, it has been proved, that even some initial (not always very skillful) attempts to verify some of the hypotheses related to the phenomena of consciousness received immediately a special significance as they (indirectly) answered

philosophical questions already existing, and took stands *pro et contra* the existing philosophical theories. Thus the philosophical burden inhibited psychological studies of global themes such as the consciousness or, for example, the will, since a discussion on the will inevitably will drag along major philosophical problems such as the questions of freedom and necessity - determinism/indeterminism.

That the phenomena of consciousness have been brought back into the focus of interest in psychology from the outside, is another paradox. This was provoked by relevant events in the field of surgery on one hand and developments in technology on the other.

By dividing the brain hemispheres, in operations performed on patients suffering from a special type of epilepsy, surgeons made it possible for psychologists to have an insight into *the divided mind*. The idea came from G.T. Fechner, who claimed in the middle of the nineteenth century, that cutting the corpus callosum would result in two independent consciousness. Fechner was the founder of psychophysics, the first experimental discipline which introduced measurements into psychology. He believed that the scientific approach to psychological phenomena must be in principle the same as the approach to phenomena in physics or any other natural science. Reflecting on the symmetry of the brain, and believing that the consciousness is only a function of the brain, he assumed that by cutting the connections between the brain hemispheres two independent consciousness would appear in the same individual. However, he believed that such an operation would never be possible. William McDougall, a well-known psychologist from the beginning of this century, was much provoked by this idea. He declared that if he fell ill with a terminal disease, he would ask the famous neurophysiologist Charles Sherrington to perform such an operation on him, i.e. to cut his corpus callosum - only in order to prove that Fechner was wrong. McDougal believed that there could be only one consciousness in man. Fechner, however, was not wrong (cf. ref. [1]). Yet, his idea of a divided or dual consciousness was proved correct only a century later, when surgeons performed this operation on a man. In this way they opened new fields of research not only in psychology but in neuroscience as well. Under their influence, also, the consciousness as a subject was reintroduced into psychology.

Another positive provocation for the return of this subject to psychology came from technology, especially from the branch concerned with simulation of neural nets. Namely, there is an inspiring history of human attempts to make a machine that could simulate some human activities. The practical side of this achievement would be to use this machine instead of human work. On the other hand, it would prove that we understand the nature of our being. The Cartesian spirit of the eighteenth century, the notion of man as a machine, the belief in our full physical and biological belongings to the patterns of our natural environment, all these preceded and had a part in it. The construction of a machine that can simulate some human activities is not limited only to our muscles and senses during work, but is concerned with the

simulation of mental functions such as perception, or special kinds of memories, etc. The first machine, *the perceptron*, was constructed by Rosenblatt in the middle of this century [2]. Its operative goal was the imitation of the process of perception. With the development of electronic technology and with the creation of more powerful computers, interests in the simulation of mental processes became wider. Since computer technology opened the way to a more natural process of decision-making, the organization of neural nets became a subject of special interest. The brain as the most complex system in nature, and the principles of its organization have become a high but still a rather distant goal towards which neural net researchers are oriented. Many new problems have arisen, the most interesting of them for psychologists being the problem of *virtual consciousness*. Could a machine solve problems analogously to the human brain, i.e. to "think" in a certain way? Can a machine think itself, namely form a certain kind of self-consciousness? The inevitable next step was to find the answer to the following question: is it possible to reach the principle of organization of the mind on the basis of experience with the simulation of neural connections and on the basis of experience with the simulation of the process of decision-making in neural organization? It is clear that the interests of engineers and the trend in contemporary electronics have encouraged studies of the mind and of the consciousness in psychology.

These developments, these impulses from surgery and technics, however, brought a substantial change to the treatment of the phenomenon of the consciousness in psychology. We should remember how, in general, scientific knowledge about the phenomena of the consciousness was obtained. Having proclaimed its alignment with natural sciences, psychology, at the end of the nineteenth century, started to introduce experiments in some relatively narrow fields: psychophysics measured the thresholds - sensory indicators in the first psychological laboratory in Leipzig, W. Wundt measured the RT - the reaction time to different stimuli, Herman Ebbinghouse, some time later, measured the dynamics of learning nonsensical syllables (cf. ref. [1]). The experimentation did not reach very deep, but the gist of these experiments was the study of the operative characteristics of mental processes - of the borders (thresholds) at which cognition begins, of the degrees of finesse in sensory changes (differential sensitivity) of the capacity of the so-called short-term memory, etc. In fact, this is research into the correspondence between the world of stimuli, physical dimensions outside the subject and his subjective experiences. This approach, however important for the constitution of a scientific view on psychological life, did not reveal much about the deeper processes of the human psyche. This remained approachable only *from the inside* - through introspection, through self-observation of the phenomenon of one's own consciousness.

Introspection is, of course, a method which has been used for several millenniums to obtain experience about one's own psychological life, as well as in discussions about it. Introspection has given important results in observations about psychological life, rules and even laws (e.g. unsurpassed laws of associations). They were obtained by looking carefully into one's own private zone of the consciousness.

One should be aware of the fact, which in this world of western civilization is sometimes forgotten, that the same methodological instruments have been in use in the traditional thought of the Far East as well, for thousands of years. There, too, introspection opened the main, and for some the only way into the world of human spirit. There are significant differences in the use of introspection in the East and in the West. Researchers in the East developed their own techniques of breaking through into one's own inner world, how to explain the complexity of the human consciousness, the composition of the soul and other problems. They were passed on by a teacher to a learner in personal contacts. During the involutionary journey the discovered component of the consciousness was given a name and a status of an inner entity, which each student had to identify again for himself. Noise in such a kind of communication was considerable. This kind of approach resulted in very little written material, the description is methodologically uneven, the terminology varies in meaning. All this further increased the noise in communication. In western culture, introspection was much less used, much less systematic and disciplined. It was taken up only occasionally and spontaneously by thinkers of different orientations. Roughly speaking, they returned to it only to record some of their spontaneous findings. Systematic use of introspection under the supervision of a guide is not known in the West.

At the beginning of this century, approximately at the same time, Alfred Binet in Paris and a group of professors at the University of Wurzburg - Marbe, Woth, Kullpe, Ach, Messer, Buller, etc. made a fresh start (cf. ref. [1]). They intended to combine the good sides of systematic description from the natural sciences with introspection. Thus, they began a series of experiments in the psychology of thinking. Their intention was to ensure the reliability of their findings achieved by introspection, ranking the types of thinking in the simplest way possible. The criterion for the objectivity of such findings would be obtained through *interpersonal concordance* of the subjects. This method was called *systematic experimental introspection* and it gave a great impulse to the psychology of thinking and psychology in general. It was believed that this method would enable psychologists to make a break into the depths of mental processes. What was left of this method at the end of a period of development did not avoid the old curse: it dealt with a private inner space, the descriptive vocabulary was unreliable; efficiency and reliability of the method required a great amount of practice. (Wundt gives a figure of ten thousand introspective trials as necessary to obtain a reliable scientific fact!) But what eliminated this method from psychology was its elementaristic orientation (as contrasted with the holistic approach that followed) and the appearance of behaviorism. Behaviorists proclaimed that the subject of psychological research should be only something that can be observed in the behavior of the subject (i.e. from the outside). That is why they attacked everything reached from the "inside" by introspection, all so-called mentalistic concepts. In this way any further use of systematic experimental introspection came to an end.

Under the influence of behaviorism, introspection and all the concepts formed by this method were eliminated. The interest of psychologists in the consciousness was considerably reduced or even completely lost. We should remember that for a great deal of the psychology of personality the primary interest shifted to the unconsciousness - the consciousness remained the object of interest only as a polygon for contents that appear from the unconsciousness masked in symbols.

A certain line of continuity of interest in the phenomena of the mind was maintained for half a century only in cognitive psychology, mostly due to the appearance of *Gestalt Theory*. Gestalt psychologists first made a turn in the methodology of psychological experiments. Instead of earlier elementarism, they proclaimed the holistic approach to the phenomena of the consciousness, following the idea of Edmund Husserl that in each science the basic approach to phenomena should be without prejudice, interpretations, breaking into parts. One should approach a phenomenon by describing it as a whole, as it primarily appears. In research into the phenomena of the consciousness, of perception in the first place, conducted at the time by Gestalt psychologists, this change of attitude brought great progress. The primarity of the whole was established in perception, the principles of organization of the whole were found (constellation factors of Max Wertheimer), the dependence of the perception of figures on the characteristics of the background was recognized, phases of problem solving in thinking and learning by insight were observed - cognitive psychology was constituted as very close to biology and natural sciences in general (cf. ref. [1]).

Thus, after exploration of the consciousness in the nineteenth century, which had been reduced to establishing the boundaries of (sensory) cognition, the speed of its installment and the dynamics of its short-term memory, an important step was made in the first half of this century in reaching deeper mental processes, towards cognition. How important cognition is we can already see from the fact that since ancient times there has always been present the following idea of equalization: to be conscious means to perceive.

This same line of thought, launched by the psychology of the consciousness and then continued in Gestalt Theory, is represented in the second half of this century in a branch of experimental psychology called *Cognitive information processing* (cf. ref. [1]). Cognition is understood as an act of communication between the environment and the personality. They also claim that the models from the Theory of Communication can be applied further, namely, to take place inside us! By simple but well controlled experiments in which the speed and punctuality of solving (cognitive) tasks are recorded, experimenters, in fact, observe cognitive operations in series, their characteristics of input and output, capacities of individual suboperations, pattern of suboperations in a single cognitive process. The language of the Theory of Information is used, cognition is treated as a whole (undivided into separate processes of perception, thinking, memory, etc., as it used to be), communication models are constructed. This branch of psychology represents a

dominant breakthrough for experimental psychology at the end of this century. It has given a new impulse to experimental psychology: the favorite subject of behaviorists - the rat - is abandoned and the man enters again the psychology laboratory as the main subject; processes in his consciousness become again the main field of scientific research.

What is relevant for our topics is the following: there is no single theoretical stand concerning the phenomenon of the consciousness. This branch of psychology propagates a new variant of structuralism as an implicit idea. As distinguished from structuralism from the end of the last century, they do not deal with elements of mental processes. It is the composition, the construction of cognition that is considered. Instead of some psychological elements, we have here discrete suboperations in a series. The consciousness, we have already stated, is a subject which is reluctantly mentioned, but apparently its composition is a topic for discussion. A commitment to strict experimentation, naturally, does not allow discussion about anything that can not be operationalized.

Another, partly a parallel way, can be found in the research concerned with physiological (or in general - material) correlated of psychological functions. This is a complex juncture of scientific disciplines, ranging from neurophysiology and the physiological psychology to biochemistry or even immunology, all of which we shall try to cover under an optional name: *neuroscience*. Research in this complex of disciplines contributes important components to understanding the functioning, for example, of the brain on the broadest scale. However, all of them are under the old curse, mentioned so many times in the discussions about the relation of body and mind: it is a neural process, the correlate of the mental - but we still do not know if by this the bridge between the soul and the material has been crossed.

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In our Laboratory for Experimental Psychology some research projects have been carried out during the last thirty years, which, we consider, indirectly make it possible for us to state something about the consciousness - this most difficult subject in psychology. Our experience concerning the phenomenon of the consciousness comes from two sources: (a) *from research on the effect of hypoxia on cognitive processes* and (b) *from research on the composition of dreams*.

Ad. (a) Hypoxia is the shortage of oxygen in tissues. As it is well known, all tissues are not equally sensitive to this shortage - the nerve tissue is more sensitive than others. The brain is the most sensitive to the reduction of oxygen, but even inside the brain there are differences. The cortex needs most oxygen, the gray mass much more than the white. In the gray mass, again, neurons of the cortex are not of the same sensitivity. The fact which is relevant for us is that nerve functions show unequal sensitivity *depending on philogenetic age* - young functions are more

sensitive than philogenetic older functions, and if there is a shortage of oxygen, they stop earlier [3]. This makes a special kind of experimentation possible: the "intensity" of hypoxia is varied in order to decompose the complex functions and distinguish them in accordance with their philogenetic age.

Experiments on human population were carried out in a clima-barocamera. By pumping out the air, simulated heights above the sea-level were achieved. In this way the inflow of oxygen in the air which the subject breathed diminished and hypoxia of various effects was created. In principle, the more complex the functions, the more sensitive they are to hypoxia. Reasoning is first affected. The subject becomes uncritical, his field of vision narrows, selective attention diminishes, emotions are more difficult to control. It has been proved, too, that hypoxia has some effects generally - it causes a certain regression of the consciousness. This has been proved by batteries of tests already in mild hypoxia on relatively small heights of 2,500 to 3,000 meters (it is considered, however, that some more significant effects of hypoxia are obtained if the subjects stay at a height of 5,500 meters for about twenty minutes). If hypoxia is increased, a significant change in the organization of functions takes place, the organism defends itself from a stress situation not only by reduction of less important functions, but also by some global changes in the organization of the system. Thus, in the barocamera we can see behaviors more like prehistoric and cave man than a contemporary subject. One general principle could be noticed: the reduction of consciousness tends to simplification and preservation, sometimes even to strengthening of the reduced number of more important functions on behalf of functions of secondary importance. Finally, the very loss of consciousness due to the lack of oxygen happens considerably before the loss of functions vital for the preservation of life. Consciousness here has a clear position in relation to other functions.

Ad (b) In the last decades, research on dreams has made progress after being freed of the tutorship of psychoanalysis and its dynamic derivates. Some techniques of analysis of the composition and content of the dream have been developed. In them the stress is placed on the language of dreams, on semiotics and the syntax of dream [4-7]. This approach is named *Cognitive Analysis of Dreams*, although both emotional and conative contents are considered. The main idea behind such approach to dreams is basically to try to apply the language of the theory of communication and also model constructing, successful in the field of cognitive information processing, to the dreams organization research.

The studies that have been conducted in our laboratory during the last twenty years, mostly on student population, were focused on the language of dreams - the cognitive material which the dreams are made of [8], as well as on the composition of dreams, that is on the way in which "the story" of the dreams is built [9]. On the basis of such studies we can also generalize about the nature of the phenomenon of consciousness itself.

There is something that is called *the consciousness of dreaming* - a specific consciousness in dreaming different than the "conscious" consciousness in waking state. It could be supposed that the two phenomena in question are so different that findings about one of them do not enable us to draw conclusions about the other. In our opinion, though, it is exactly the analysis of the consciousness of dreaming and of the language employed in dreams that gives us information about consciousness in general, and it is the consciousness of dreaming that in fact enables to make some analysis of consciousness which would be impossible in waking state.

Let us remind ourselves that ever since the antic philosophy dreaming has been considered as something like a regression of consciousness, that Carl Gustav Jung views dreams as an archaic language through which the unconscious is expressed, and that the phylogeny of dreams is explicitly mentioned by Sigmund Freud. He believed that one day we would be able to differentiate between those aspects of dreams which are individually determined and those which are the results of the phylogeny [10]. Conceptions like these are close to later Fromm's ideas explicated in The Forgotten Language and to our conception of dream as a postponed consensus between the subsystems of the brain, some of which are clearly phylogenetically different [11]. However, the general conclusions of our research in the cognitive analysis of dreams, those conclusions which were related to consciousness, were, unexpectedly, compatible with the findings of seemingly quite distant researches, like those that dealt with hypoxia. They both complementary participated in the same description.

Here is what can be used from the cognitive analysis of dreams to improve our understanding of consciousness. In the first place, the finding that there is a larger presence of motor representations in the language of dreams. Usually, in reports about dreams visual contents are dominant, followed by auditory ones. After some training in introspection, however, the subjects' reports significantly change, the number of motor representations increases and they are placed in the basis of the report as *relations* or *the primary space of meaning*. The experiments that involve sudden (purposeful) waking of asleep subjects and immediate description of dream content yield equivalent results. In this type of research, among others, the introspective report, in a modified form, has been rehabilitated and has become an important source of reliable scientific findings [12].

The second area of interest for our topic is the phenomenon of falling asleep. Of course, physiology has, in its terminology, described in detail the phases of falling asleep, but in this discussion we do not deal with them. In our research the introspective descriptions of entering sleep, both spontaneous and those obtained by interrupting subjects' falling asleep, were used. It was shown that in the course of falling asleep the place of contact with reality moves towards the inside, or, in the words of our subjects, the "screens" on which the events take place replace one another in a successive manner, so that the focus of activity is moved progressively towards the subjective inside. At the beginning the three dimensional space is

eliminated - contact with reality becomes organized as a two dimensional area (therefore the "screen" analogy), placed somewhere at body's periphery. That is probably the same as what was described at the beginning of the century as the difference between epicritic and protopathic sensitiveness, the shift from experiencing the objects to experiencing the stimulated point on the body [13]. This is not yet a characteristic of dreams, it is only a necessary condition for entering sleep. In it we recognize something as an overture for dreaming - the elimination of rich and provocative external reality and the reduction of immediate experience to a simpler form. But, doesn't this look like some regression of consciousness too?

In the following phase of entering sleep the appearance of representations from separate modalities (visual, auditory, motor, etc.) is described, followed by reporting about integrated representational material from these different sensory modalities and about the forming of some sort of the first rudimentary "dream movie". In it the residual sensory excitation and the elaboration of this external material can be found, together with merging of this material with representations. It is all going on in some internal sensory space connected to a particular modality, for instance internal visual space. It seems that for some time these internal spaces work separately, and that the integration of information from them takes place later and on some other, deeper level.

There are several hypotheses about that mechanism, from the ideas of Pavlov that it is the residual excitation in the sea of cortex inhibition that is in question, to ideas that the phasic brain excitation (during the REM phase) activates the hippocampal-neocortical memory system and expels, squeezes out sensory pictures - representations from it as from some reservoir. The dreamer then integrates these pictures (the laws of association?) and out of their succession he makes the story of the dream [14]. Whatever be the way in which it is formed it is a fact that the pictures do follow one another or integrate in some internal cognitive space ("screen" in the words of our subjects) which is not the perceptual one from the waking state. It rather looks like the cognitive space for representations, of the "conscious consciousness", the one of waking state. In distinction from it, this cognitive space of dreams has somewhat clearer pictures and the possibility of simultaneous influx of information from different modalities. Obviously, with the transition to that level a step is made towards a deeper internal space of information processing.

That the deeper levels of processing are involved can be seen from the description of the experience of migraine sufferers who sometimes upon waking up see the migrainous snake (spiral snakelike disintegration of the visual field) already quite developed. Obviously, it develops somewhere else, in some other space, which the subject reaches only after awakening. Otherwise, the phenomenon lasts around ten minutes in waking state, and it always has a strict procedure: "the tearing apart" of the picture starts somewhere near the center of the visual field and it expands slowly until it leaves the visual field in 10 - 15 minutes [15]. Migraine patients sometimes fall asleep during that time and then the picture disappears, although "the

snake" hasn't left the visual field, and if the falling asleep is interrupted it appears again quite developed, because it has been "active" in the meantime, it has developed in the field of which the patient hasn't been conscious.

Out of all these findings a conclusion important for our work can be drawn: *consciousness is a composition of cognitive functions*. The hypoxia experiments clearly confirm this stratification, and they also tell us that this composition is made of functions of different phylogenetical age. Information that is processed there can be of different origin: external (the effects of direct stimulation) or internal (memory, emotions and conation). One of its most important characteristics is the *reduction from parallel to linear information processing*. The consciousness makes an imbalance between pieces of information - out of the large amount of the parallel incoming information the processing of one part of the stimulation is facilitated at the expense of the rest. Let us remind ourselves that this is a principle of functioning recognized already in perception, on the surface of cognition, as it was discovered already by Gestaltists in their laws of perception. The deeper cognition is, this principle is even more emphasized. We see the significance of the selection of information in relation to the need to differentiate between the critical information and the information that is biologically indifferent. The consciousness can also focus on itself - this is the basis for the appearance of the self-consciousness. In general, a view of the inside does not enable us to directly experience the complexity of cognition - the consciousness appears to us integral.

The meaning of this arrangement of spaces (functions) of various depths is this: our early ancestors were primarily reactive creatures, and the development of our species was directed towards the more and more mediated (re)acting. In order to postpone the decision and thus increase the chance of choosing a better alternative, it was necessary to internalize the effects of the stimulation. An internal screen had to be formed, on which the relevant external reality would be represented. On that screen it would be represented with a picture which would be less precise, but which would *enable greater dynamics*. This principle was consistently respected - the deeper the "picture" of the external reality was placed, the more abstract and the less lasting it became, but it also enabled greater and greater dynamics. Our interior manipulated the pictures and that was now much more dynamical than directly manipulating the objects in the external reality. And most important of all: *it made prediction possible.* The consciousness has thus developed from the need to postpone reactions, and its main purpose is to increase the degree of freedom in decision making.

From everything mentioned above it can be seen that at the most general level, in explaining the phenomenon of consciousness, we support and apply *functionalist approach*. Consistent explanation of consciousness, as a complex combination of functions of different phylogenetical age, we see only in the light of the development of communication of living beings with their surroundings, therefore - in biological determinism. In addition to this, our findings about the primary space of meaning,

which originates from motor representations, directly support the main ideas of the pragmatist theory of meaning, close to the conceptions of William James.

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BIOLOGICAL BASIS OF CONSCIOUSNESS

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Abstract. Consciousness is *prerequisite* of total human mentality, and on the other hand, it is the final *outcome of synthesis* of all processes discovered until now, and it might be *much more*, as well. We should not forget that we are dealing with unsolved puzzle. Neurophysiology of awareness belongs to a well developed concept. It does not represent overwhelming task for a student in neuroscience, and this is demonstrated in sections "Neurophysiology of awareness", "Thalamus and attention", and "Vertical unit". But if we want to enlighten another aspect of consciousness - i.e. self-consciousness, then we face almost irreproachable obstacles as we find small number of reliable scientific supports. In section "Biological indicators and cortical activity" some significant correlates of consciousness are shown, even self-consciousness, such as: EEG explorations (α–activity), radiotracing results, and evoked potentials. In section "Cognitive somatosensory evoked potentials" we consider neurophysiologic correlates of free will, attention, and conscious perception - cognitive N150 and P400. The section "On self-consciousness" enlightens self-consciousness as a part of Cousin's definition, presuming introspective method which is irreproachable for exact measuring - the demand of any strict science. By a reduction from complex to simple, it is possible to study self-consciousness through identity phenomenon by test of "identification in mirror". Related to it, the problem of lateralization of the function is discussed. Section "Conscious intention and voluntary attention" displays neurophysiologic correlates of some subjective psychic phenomena, such as conscious intention an voluntary attention (e.g. α–blockade with open eyes, Desmedt experiments with cognitive N150 and P400, or three negative surface potentials: contingent negative variation, readiness negative potential, and negative potential of goal directed movement). "Self-consciousness and emotions" displays connections between biology of emotions (aversive and hedonistic systems) and psychological experience, the knowledge of it - self-consciousness of emotions. In final section "A few words more on attention and self-consciousness" an organic basis of self-consciousness is proposed. Self-consciousness appears always to be a sort of knowledge *par distance* of one's own mental states either as integrated wholeness in personality, or as any detail of mental structure. This knowledge *par distance* does not jeopardize identity of personality, and brings no alienation. Perhaps, self-consciousness is a crucial phenomenon which transforms us from reactive to contemplative creatures. The first encounter with one's own self-consciousness might be a breaking point, leading oneself to critical reasoning and objective judgment.

Keywords: *consciousness, awareness, self-consciousness, identity, superficial negative potentials, cognitive evoked potentials*

If we are supposed to approach the questions of human consciousness, it is advisable to remember Blaise Pascal's thought:

"One has no right to deny some fact only because it seems to him *unbelievable*, because we have only our in essence deceptive *customs* as the only means by which to discern possible from impossible".

Consciousness is the *prerequisite* of total human mentality, and on the other hand, it is the final *outcome of a synthesis* of all processes discovered until now, and it might be *much more*, as well. We should not forget that we are dealing with an unsolved puzzle.

Neurophysiology of awareness belongs to a well developed concept, and it does not represent an overwhelming task for a lecturer. But if we want to enlighten another aspect of consciousness - i.e. self-consciousness or its synonym - selfawareness and clinical psychiatric concept of orientation (spatiotemporal, alo and autopsychic), then we face almost insurmountable obstacles. The closer we come to the concept of *selforientation*, the greater our frustration grows. If selforientation is decomposed and enriched by the concepts of *integrity and identity of personality* the position of the explorer of selforientation i.e. selfconsconsciousness is slightly improved. The point is that self-consciousness denotes knowledge of oneself, of one's position in the world, in real surrounding according to other parameters: space, time, other beings, objects and phenomena. This comprises the *knowledge* about one's deeds, feelings, thoughts, experiences, attitudes and interests. Cousin wrote: "We not only feel, but we know that we *feel*; we not only act, but we know that we *act*; we not only think, but we know that we *think*... The peculiar quality, the fundamental attribute of thought is to have a consciousness of itself. Consciousness is the accompaniment of all our faculties; and is, so to speak, their echo" [1]. At the same time, self-consciousness means unity through integration into personality despite, superficially looking, disharmonious and mutually excluding strives. It also means personal specificity, uniqueness.

The knowledge of identity - indicates the comprehension of the personality sameness in spite of everlasting changes.

So, to conclude, it is possible to discern three meanings of consciousness: 1. wakefulness; 2. consciousness as specific attitude of "knowledge" concerning mental contents and activities and 3. self-consciousness as specific attitude of "knowledge" of oneself.

1. NEUROPHYSIOLOGY OF WAKEFULNESS

An old truth says: Whenever the Nature finds efficient solution, it is applied regularly throughout phylogenesis and ontogenesis, and physiological mechanisms for awareness illustrate it very appropriately. The structures and mechanisms supporting awareness are inbred as a part of less developed brains resembling human brain in a great degree. The fact opened a vast experimental field permitting essential breakthroughs. All mammalian brains in brain stem enclose neuronal network with oscillating circuits which produce *the state of awareness*. It means general and non specific mental readiness for conscious psychic activity. It also

means non specific CNS (central nervous system) readiness for registration and processing of received stimulation, thus being turned into information.

When we say for someone that his physiologic consciousness is normal, then we mean he is not unconscious and asleep. In practice we check if a subject fulfills verbal orders, and if stimulation of periphery receptors gives appropriate reactions. Awareness is the prerequisite for normal conscious mental activity, and with attention makes energy function group [2].

Giuseppe Morruzi and Horace Magoun published an article [3] in the first issue of "EEG and Clinical Neurophysiology" in 1949. And this has become the crucial discovery for understanding long lasting awareness. Although there was a preliminary hint about connections between brain stem and cortical activity [4], they clearly demonstrated the change of EEG pattern caused by mesencephalic part of the stem reticular substance stimulation: previous α–activity, as the sign of relaxation (or low mental activity), vanished and desynchronized activity of β–frequency developed instead. Simultaneously, in behavior were noticed marks of increased awareness, i.e. arousal reaction. The same desynchronized pattern appeared in any mental and physical engagement, or when any sensory channel was excited.

To the cited article, previous investigations had cleared the way, and the most important ones were Bremer's experiments [5]. Bremer was the first to show that awareness depends on brain stem (cf. Fig. 1). The low transection disconnecting brain stem from back spine (encephal isole) did not influence EEG appearance. But high brainstem transection, immediately above lamina quadrigemina (cerveau isole) put an experimental animal in a state resembling normal sleep.

Moruzzi and Magoun stimulated mesencephalic stem system directly under upper Bremers cut, and a generalized bilateral cortical desynchronization was registered, as a sign of general activation.

Stem reticular formation goes through brainstem following its midline axis. Histologically it is composed of tiny neurons interwoven into a network with abundance of oscillatory circuits. When a stimulus enters the network, a long lasting selfexcitation process is initiated. Upper and lower ends of brainstem reticular substance terminate with outlet tracts. The rostral fibers stimulate entire telencephalon cortex forming ascendant activating reticular substance system (AARS) making neurophysiologic and neuroanatomic substrate of the system keeping us constantly awake.

Desynchronizing influences reach cortex by two ways (cf. Fig. 2).

Beside direct reticulocortical system (AARS) called mesodyencephalic system (synonyms: mesencephalosubthalamic, mesencephalo hypothalamic system), another activating system has relay in thalamic reticular nuclei. In this system fibers leaving stem reticular substance make synaptic stop within architalamic nuclei [6,7], non specific thalamic nuclei (intralaminary nuclei, centrum medianum, nucleus dorzalis medialis, nucleus anterior thalami), and afterwards continue to make synapses with

neurons forming cortical vertical units (see below). When we stimulate directly archithalamic nuclei, after a short latent period architalamic neurons begin to stimulate brain cortex. But cortical stimulation does not overlast direct thalamic stimulation, in contrast to AARS with much longer latency and long lasting cortical excitation though stimulation stopped.

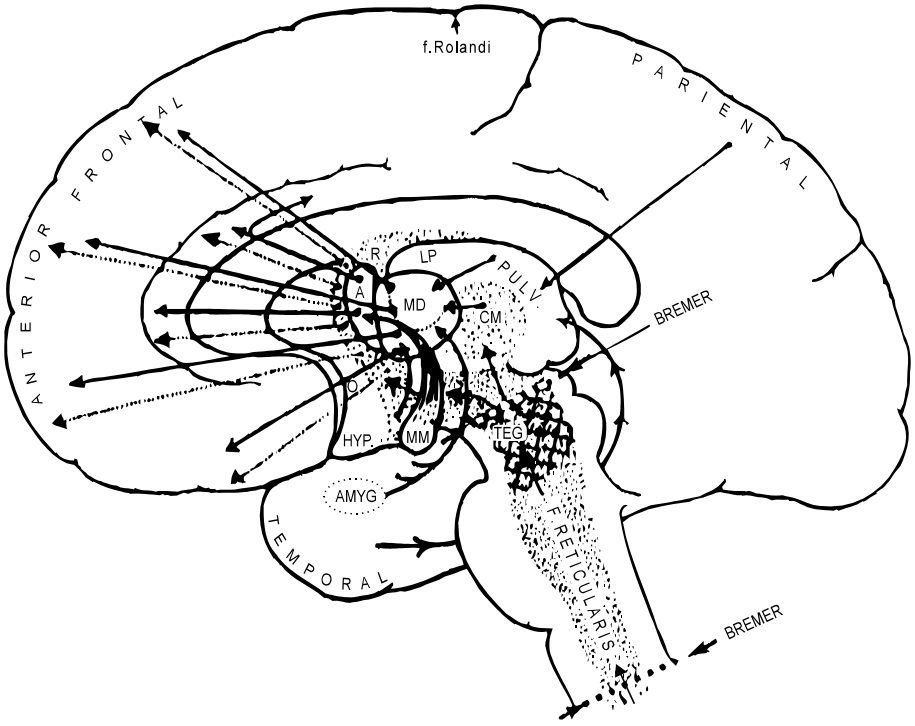

Figure 1 *Bremer's brain stem transections.* Upper cut separates brain stem from telencephalon causing abolishment of the stem reticular activation, and the animal is drowsy and inactive. The zone under upper cut marked as TEG (tegmentum mesencephali) later was stimulated by Moruzzi and Magoun.

2. THALAMUS AND ATTENTION

There exist three well developed systems in thalamus ("the gateway to the cortex") according to anatomy, electrophysiology and particularly by type of thalamocortical and corticothalamic connections. Thalamic neurons are grouped in nuclei, and they are divided in three "thalami". The oldest part is *archithalamus* (consisting of nonspecific nuclei), younger - *paleothalamus* (made of specific nuclei), and joungest *neothalamus* (embodying associative nuclei) [6-8].

As already seen, archithalamus is a part of cortical activating system and we are going to discuss its prominent role in the attention generation and consecutively in formation of α–rhythm.

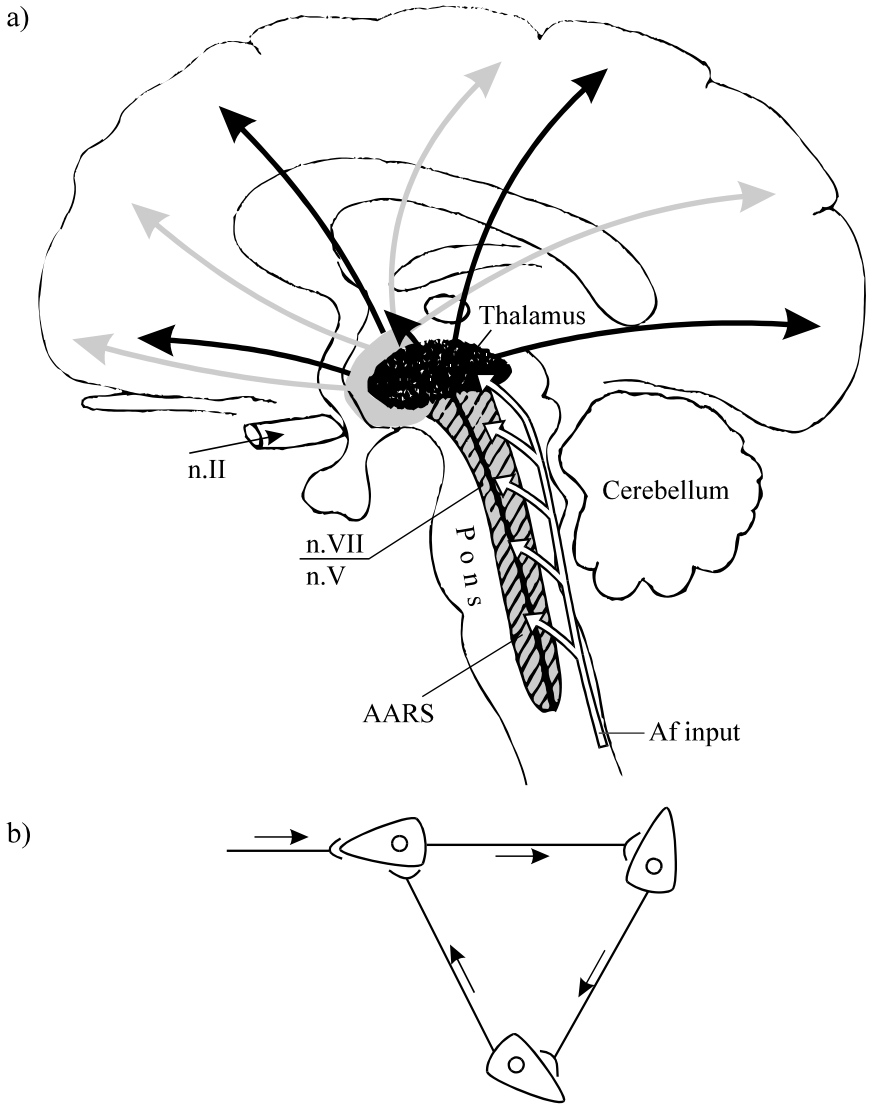

Figure 2 *Tonic (AARS) and phasic (thalamic) cortical activation:* (a**)** In brightly shaded area is represented AARS (ascendant activating reticular system) coming from brain stem reticular substance. Brightly shaded arrows suggest diffuse tonic cortical activation. In black is represented archithalamic system acting phasically on cortex. White arrows represent afferent specific input with rich arborizaton into reticular stem substance. (b) Simplified oscillatory circuit as a structural and functional unit of which reticular stem system is composed.

For quite a long time thalamus has been known as the principal sensibility relay. Today we know this role to belong to *paleothalamus* i.e. specific thalamus. The first crude processing of input impulses takes place in it, before cortical refinement. Paleothalamic neurons forward impulses into primary sensory cortical zones, and their electrical escort are evoked responses, evoked potentials (EPs). The connections between specific thalamus and primary sensory zones are very precise - point to point, without diffuse collateral dissemination.

Neothalamic mass is bigger than total paleo and archithalamic mass. Evolutionary, it goes hand in hand with powerful neocortical development. And thus it is not surprising that neothalamic nuclei communicate with neocortical association ("mute") areas by feedback connections.

2.1 Direct stimulation of thalamus

As far as neurophysiology is concerned, we shall summarize only direct stimulation effects of three thalamic systems.

When intralaminar nuclei of archithalamus are stimulated, over both hemispheres are registered: first desynchronization, afterwards (in barbiturate anaesthesia) *recruiting responses*, and after a while α–spindles may be registered as well [9-11].

A train of waves, forming complex evoked response, is registered over primary sensory cortex areas whenever specific parts of paleothalamus are stimulated.

After direct stimulation of neothalamic nuclei (three of them) ipsilaterally in association areas of neocortex, in very limited segments are registered biphasic waves called *augmented responses*. They can be elicited from strictly local neuron clusters with which corresponding small neothalamic neuron groups have axonal connections. The response is not generalized - bihemispheric as recruiting responses are.

We said that both mesencephalo-cortical reticular system and thalamo-cortical reticular system were activating mechanisms causing cortical desynchronization, when directly stimulated. Another similarity is diffuse distribution of their efferent corticopetal fibers. But differences are more prominent. AARS produces diffuse bihemispheric effect lasting long time (*tonic activity*), after longer latency period. The other system is not a parallel one. It is evident by significant functional differences: this system works *phasically* - effect does not overlast the duration of stimulus, desynchronization is limited to a smaller region and latency period is very short. The phasic activity is regarded to be biological basis of attention, of the focus of our consciousness or its selectivity.

It is necessary to know that all three thalamic systems are deeply interwoven, and this is the reason for always present combination of global activation (AARS) and more specific activation (thalamocortical system), i.e. synchronous tonic and phasic influences. Or take a look at sensibility with large subcortical relay - paleothalamus. Afferent tracts approaching thalamus ramify abundantly into stem reticular substance flooding its excitation energy into oscillatory circuits thus supporting the state of wakefulness (see Fig. 2).

3. CORTEX AND THALAMUS

No one part of central nervous system (CNS) works in isolation. All levels of the CNS organization are connected horizontally and vertically, locally and globally in many ways, so it does hold true for cortex itself [8, 12]. Every cortical area is bound by three types of ties with other cortical parts: horizontally with contralateral hemisphere (commissural connections); vertically by recurrent thalamocortical connections; longitudinally and transversally within ipsilateral hemisphere (associative fibers). There are very strong excitatory and inhibitory connections among neighbor vertical cortical units, as well as within the same unit among its neurons.

4. VERTICAL UNIT

Cortical neurons are stratified giving three types of cortex according to evolutionary principle, and named likewise thalamic division: neocortex (neopalium), paleocortex (paleopalium) and archaic cortex (archipalium). After accumulated knowledge through histological studies about six-layer cortex and much older three-layer cortex, and Brodmans cortical typology with zone divisions [8,12,13], in 1957 Mountcastle published observations on structural unit in somatic-sensory primary cortex [14]. Later this has been confirmed for the whole cortex, with extension to be also cortical functional units [15]. About 4 million vertical units constitute the total mass of brain cortex.

Each cortical vertical unit (synonyms: vertical column, module) is composed of a couple of thousand cortical neurons. Most cortical neurons in unit are oriented vertically to the surface of the cerebral cortex (cf. Fig. 3). The most conspicuous are pyramidal cells by size small, medium and large (in fifth ganglial layer). Stellate cells in fourth cortical layer are also vertically oriented. Vertical orientation holds true for all efferent and afferent fibers penetrating unit of whatever origin, so all electric fields are *parallel*, as their structures are.

The main principle of parallelism in vertical unit enables formation of *dipole electric fields* generated either spontaneously or evoked, as well as summation

(add/subtract) of small field values (*potentials, potential differences)* by averager technique [16].

And exactly some of these small potentials, made visible by averager technique, have become correlates of awareness, attention and self-consciousness opening incipient enlightening on relationship between brain and consciousness, what we are going to discuss later.

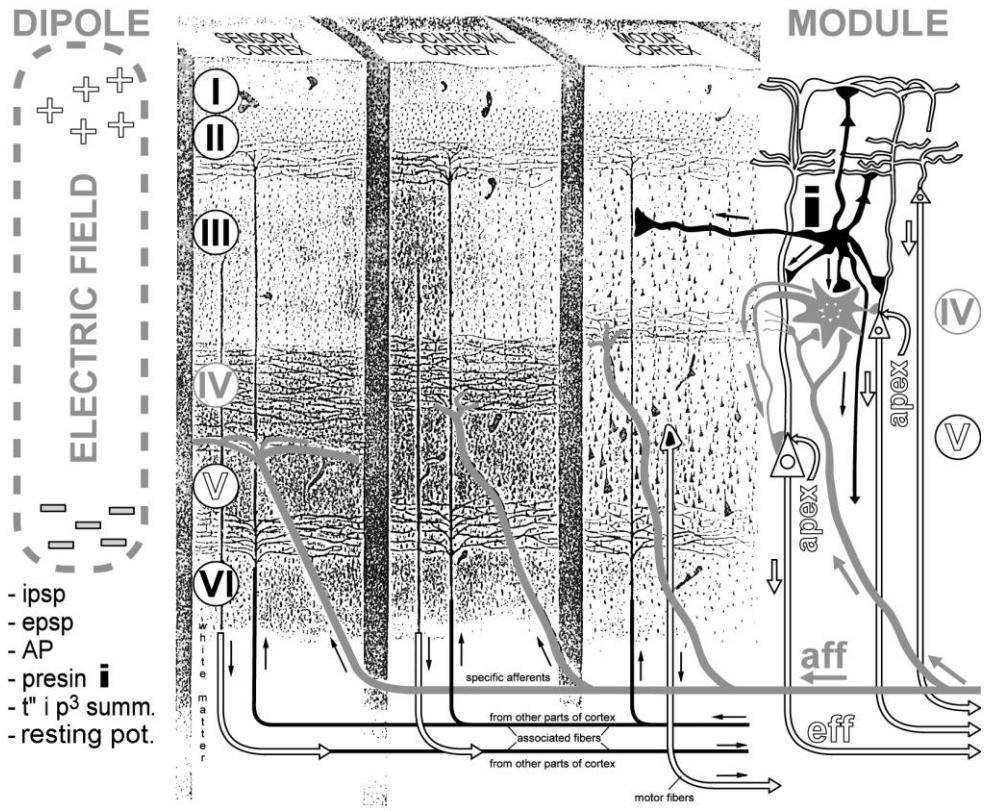

Figure 3 *Organization of cortical vertical unit and electric field.* Central part of the figure shows three cortical units disclosing three different types of neocortical organization: sensory, associational and motor. On the right side of these three cortical units a very simplified and very schematic inner organization of a cortical unit is displayed. In white arrows are represented pyramidal cells from whose apexes apical dendrites project to superficial first and second cortical layers. Brightly shaded paths are sensory-afferent inputs terminating on its stellate neurons, also vertically oriented as pyramidal cells are. In black is depicted inhibitory neuron acting inhibitory within its own cortical unit, but also spreading its inhibitory influence into other units in the vicinity. On the left side electric field is designed with a short list of electrophysiologic events having impact on it, modifying intensity and reversal polarity of dipole. It should be noticed that parallel organization of the component cellular parts in cortical vertical unit is essential for formation of electric field.

When an axon enters a vertical unit, its complete arborization does not leave the unit. The axon branches throughout the unit making synaptic contacts with numerous neurons being part of the unit. Convergent input pours into unit, and after processing it sends divergent output shaped in time/space patterns mediated by mechanisms like time and space summation. At the same time the vertical unit sends inhibitory influences toward other units in its vicinity. Units are overlapped which means that all neighbour units process the same inputs. A few thousand cells bound in vertical unit can create enormous number of patterns, differing in intensity, duration, and sequence of discharges, with a possibility to simultaneously engage many or a few neurons *in the same phase of activity*. The same variety of combinatory probabilities exists for modular engagements, so each vertical unit is a link between input and output. But not a simple one. A module is supposed to possess intrinsic power, internal nervous activity connecting old information and new ones, and these are the basis of *self-consciousness* according to descriptive Cousins definition [1].

5. BIOLOGICAL INDICATORS AND CORTICAL ACTIVITY

To follow and measure intensity of the brain cortex activity in various conditions, several methods can be applied, e.g. tracing radioactive isotopes in blood stream, evoked electrical brain activity and spontaneous activity of EEG. So they can be used as indicators of level of consciousness, and under convenient circumstances even to be correlates of the very subjective states such as self-consciousness.

5.1 Radiotracing techniques

Metabolic increase is followed by enhanced oxygen consumption and blood rate. If radioactive isotope (e.g. radio Xenon) is taken in, or injected, it accumulates in higher concentration in the regions where blood rate is higher, i.e. where brain tissue activity is more vivid [17]. These facts permitted far reaching conclusions. For instance, when a subject thinks intensively on his hand movement, when there is *only will intention without performing movement*, bloodstream is enhanced in frontal lobe, mostly in prefrontal region. When movement actually takes place, blood circulation in prefrontal lobe calms down to normal, resting level; simultaneously it is increased in gyrus precentralis, especially in the zone controlling will movement of the hand.

The highest global blood flow increment was registered during epileptic attacks and REM sleep.

5.2 Electroencephalography (EEG)

Applications of EEG in consciousness studies are of considerable value. These findings might seem unfounded unless we are aware of some basic facts on the nature of EEG.

Over frontal areas of a mature, adult brain, when subject is restful with closed eyes, β–activity (14 Hz and more) is registered. Synchronously with frontal β–frequencies, α–activity (8-13 Hz) is registered over occipito-parietal regions. Alpha rhythm is a basic sign of life, but also the sign of low activity of brain. That picture (β-α–activity) denotes spontaneous electrical brain activity of a mature adult brain. It should be noticed that very fragile synchronization bringing up α–frequency spindles is suppressed easily by opening eyes, or by any activity.

Alpha waves are formed within thalamocortical repetitive interplay (cf. Fig. 4). Direct stimulation of reticular archithalamic nuclei provokes rhythmic responses in corresponding cortical units connected with a limited group of archithalamic neurons. During intrathalamic stimulation, every thalamocortical subsystem-subdivision has identical frequencies correspondingly registered both at cortical and thalamic levels, implying that thalamic stimulation frequency is congruent with response frequency in cortex. So it seems that α–pacemaker for cortex activity lies subcortically, though there are cortical neuronal facilities for synchronization as well [18]. It depends on gabaergic postsynaptic inhibition in huge neuronal population of thalamus. Inhibition synchronizes generation of three consecutive states: excitation/inhibition/ of resting cell potential, bringing states/activities of neuronal masses into *phase* [19-21], which means the whole group is either excited, inhibited, or resting. Activity of vast neuronal population comes into phase through thalamic synchronizing mechanism.

Whenever thalamic relay neuron proceeds an impulse into cortical vertical unit, the same relay neuron with its collateral branches stimulates thalamic inserted inhibitory neuron, and this one inhibits excitation of several thalamic neurons. This is the first step toward massive synchronization by bringing their activity into phase [22,23].

All registered gross waves have their origin in synchronizing arrangement of a great number of cortical neurons, because only then summated electric fields achieve a charge strong enough to be detected by devices at our disposal.

When active mental condition takes place, in that very moment the synchronization is disorganized. Alpha activity always indicates the low mental activity. Suppressed α–waves with opened eyes is a sort of identification test for α–activity. But

it can be blocked in a number of other ways and this is of special interest for our theme, which will be shown later.

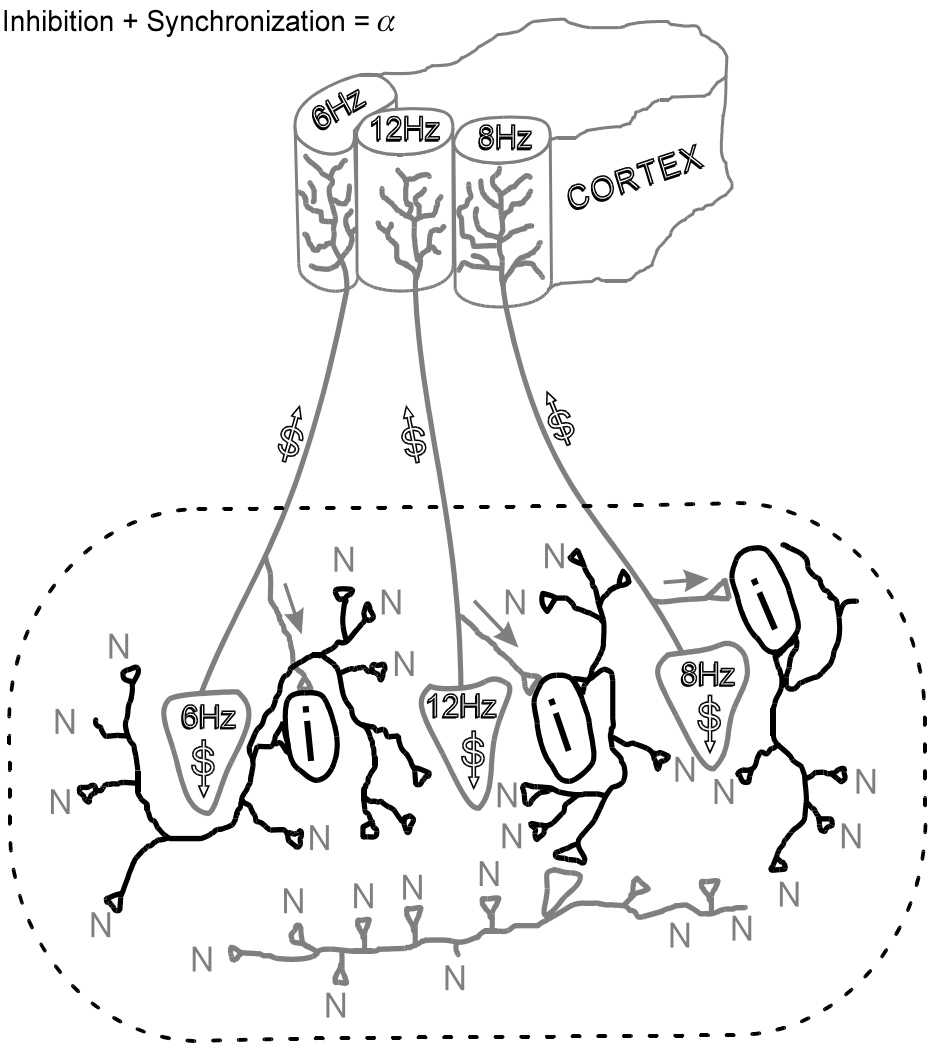

Figure 4 Thalamocortical inhibition/excitation and generation of α–rhythm. In picture can be envisaged upper part - cortex with three cortical units, and lower part - assembly of thalamic neurons. Brightly shaded paths are sketched three archithalamic neuron groups sending their arborized axons into corresponding three cortical units. Brightly shaded "N"s represent other thalamic neurons with their bodies, dendrites and axons in synaptic connection. Black neurons with "i" symbolize inhibitory neurons. It should be noticed that 6 Hz, 8 Hz, and 12 Hz in thalamus denote stimulation frequencies; corresponding numbers written inside cortical units denote response frequencies. It is also important to remark that each thalamic axon approaching neocortex gives recurrent fiber stimulating backwardly inhibitory thalamic neurons. (For more details see the text.)

6. EVOKED POTENTIALS (EP)

When any part of a sensory channel is stimulated (cf. Fig. 5), on the surface of cerebral cortex the threephasic primary response, specific response or potentials, and evoked potentials can be registered [24-29]. In primary sensory cortical zone contralaterally, primary potential is clearly readable, and ipsilaterally it is present in a weak trace. The first deflection is positive (P1 = P9) and it represents incipient depolarization deeply in fourth stratum of sensory neocortex, on the proximal part of pyramidal cell apical dendrite (cf. Fig. 3). The first potential is the result of dipole with relative positivity on the cortical surface [24,26,30-32]. It is supposed that registered potential always reflects polarity of most superficial electrical event taking place in the first or zonal (molecular) layer of neocortex, mostly originating from different fibers coming into synaptic touch with most distal part of apical dendrites [33]. After P1 (P9) come N1 (N20) and P2 (P45) waves, and afterwards a train of alternating negative/positive oscillations (cf. Fig. 6). The latter wave train does not belong to the primary evoked complex. They form secondary, or non specific part of evoked potential complex.

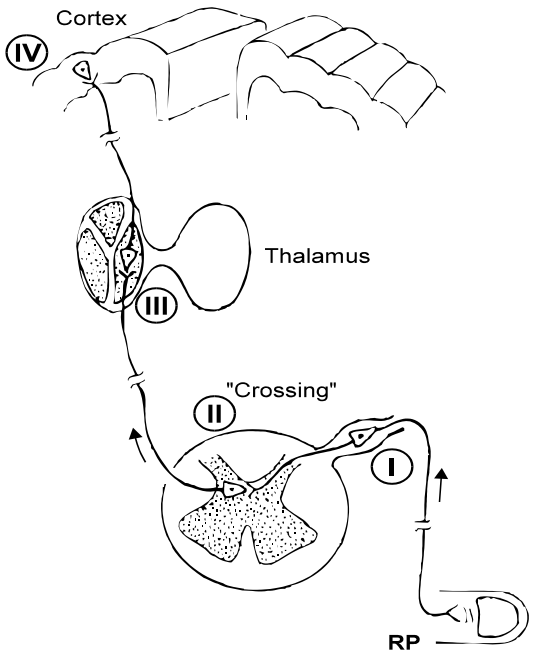

Figure 5 *Somatic sensory-afferent path.* Figure representing somatosensory afferent channel with peripheral receptors (RP) in finger; neuron I in spinal ganglion with axon crossing contralaterally and making synaptic junction with neuron II of the path; neuron III of the afferent path belongs to paleothalamus whose axon contacts neocortical neurons in Brodman 1 and 2 zones.

And just this unstable, variable secondary EP has greatest significance as potential correlate of consciousness, and especially self-consciousness. Secondary EP segment is fabricated through circuitry between archithalamic nuclei and neocortex, i.e. vertical cortical units with some AARS impact.

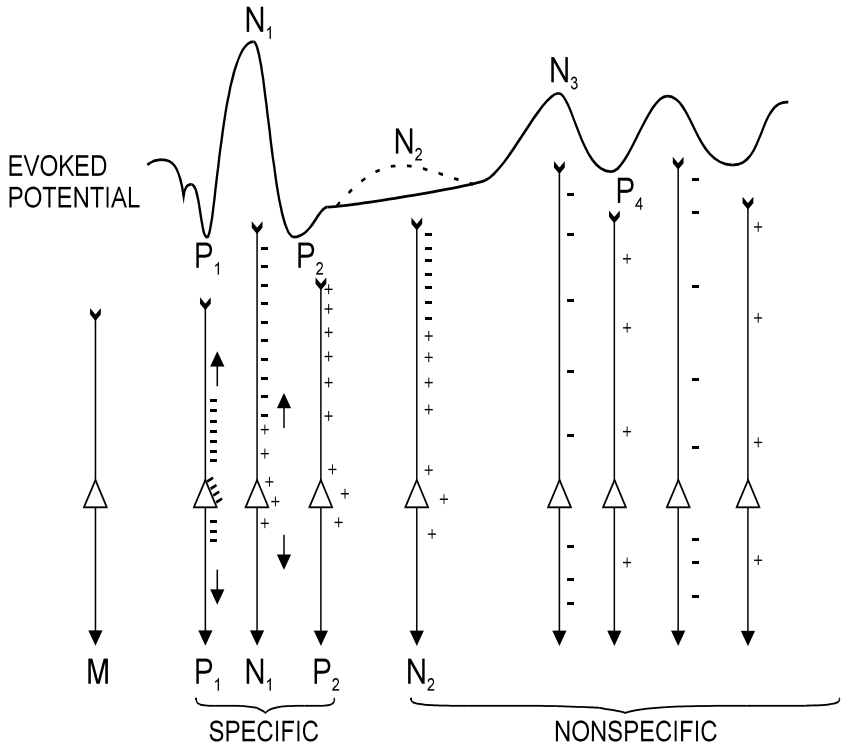

Figure 6 *Somato-sensory evoked potential (SSEP).* Registering electrode is placed over primary sensory zone for somatic sensibility. Somatosensory EP (SSEP) is wave train, train of alternating +/- deflections from the base line. Under SSEP curve are represented cortical cellular events in correlation with the registered wave. For instance, P1 correlates with incipient depolarization of stelate and pyramidal neurons in fourth cortical layer. At that moment under registering electrode is relative electropositivity. Each SSEP wave is in correlation with cellular electrical changes (depolarization and inhibition processes) as illustrated in scheme (Creutzfeld). The first three stable deflections belong to specific SSEP, and the rest unstable ones to nonspecific.

Two first waves (P1 and N1) are primary EP mediated by paleothalamic sensory relay, and they are very stable. They are not in correlation with conscious states which is proved in total anaesthesia - they are almost intact [34]. It also proves stimulation by subthreshold intensity stimulus. It produces biphasic primary EP, but subject is not aware of this experience which suggests that primary EP part has not direct attachment to conscious experience.

If, for instance, peripheral somatosensory stimulation is accompanied with conscious experience, alongside with localized specific part of somato-sensory evoked potential (SSEP) in primary somatosensory zone (Brodman 1), there regularly appears broad activation in parieto-frontal cortex (detection-radio Xenon), accompanied by disappearance of α–activity. That means that vertical units in primary sensory zone are not sufficient for conscious insight, and participation of a vast number of vertical units from free association regions, concretely parietal and prefrontal lobes, are indispensable. Diffuse, complex temporo-spatial organization is a necessary prerequisite for conscious perception.

7. COGNITIVE SOMATO-SENSORY EP (SSEP)

Each individual wave from human EP complex is marked in two ways: by succession in coming, or by time duration measured in milliseconds which is necessary to pass from stimulus artifact to the highest point on amplitude of the wave. So for SSEP we have: P1 ≡ P9; N1 ≡ N20; P2 ≡ P45; N2 ≡ N77, and so on. Three first deflections are almost invariable in their latency period. But already the fourth, N77 is significantly inconstant, because its peak takes place between 50÷130 ms with mean value of 77.

In human psychology regarding self-consciousness exceptionally important are *N140÷150 (N3) and P300÷400 (P4).* These are very low voltage potentials and for their detection averager technique is indispensable [16]. N140-P400 wave pair seems to have something to do with free will, willful intention, or volitional attention as an electrophysiologic correlate, which is to be proved in Desmedt and Robertson experiments [35-37].

A subject was faced with two different demands. Initially he was asked to pay full attention to the stimulated finger, to be utterly conscious of sensations coming from the finger. Another part of experiment required the subject to completely neglect sensory input from the finger (listening auditive signals from earphone). Finger stimulation persisted, which was evident by primary EP registered over primary somatosensory neocortex. But the subject did not perceive sensations from his finger consciously. In the initial phase of experiment while he attended sensations from the stimulated finger, bicortical symmetrically large P400, and slightly higher contralateral N140 (thicker trace in Fig. 7) clearly appeared. In the second part of experiment he willfully neglected conscious observation of sensations from the stimulated finger, and in that case N140 and P400 were bilaterally totally absent (thinner line in Fig. 7). It should be noticed that upper curves are a result of contralateral registration, and lower traces are registered ipsilaterally.

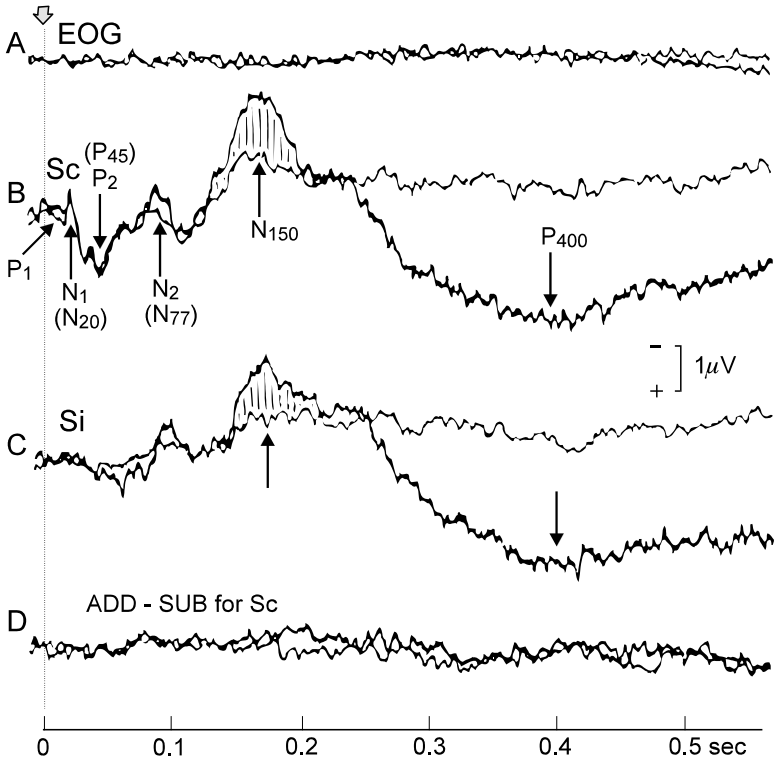

Figure 7 *Cognitive N140 and P400.* When full attention is paid to stimulated finger, prominent N140 and P400 appear in elicited SSEP (see thicker curves in (B) and (C); (B) represents contralateral and (C) ipsilateral registration). If the subject, under the same conditions, is asked not to pay attention to his stimulated finger, which is in going on, but to sound coming to him through earphones - in SSEP P400 completely disappears, and N140 is attenuated.

8. ON SELF-CONSCIOUSNESS

We judge awareness on the ground of three criteria, and all the three are objective and reactive in essence. Partially, this is a consequence of nonverbal communication with lower animal species. When we say a being to be conscious (aware, awake) we mean:

(1) It reacts emotionally adequately to the circumstances;
(2) It reacts with some degree of intelligence;
(3) It can learn appropriate, useful patterns of behavior.

These adequate reactions demand participation of attention (selectivity), short term memory (binding different synchronous activations in CNS) and long term memory (past experience) to be included in the global process underlying consciousness.

But self-consciousness is the most subjective experience approachable only through introspection. It can be later shared with other people relating it to them through verbal report.

A being possess self-consciousness if its consciousness has specific quality, the special knowledge of its behavior, its mental states, of himself/herself as defined in Cousin's [1] descriptive definition. And we think that this property belongs only to human beings. We do not expect this attribute to be present in any other earthly shape of life, not even in traces.

This confronts scientific method with an extremely difficult task, because science is always a venture to compare, measuring objectively under strictly controlled conditions, and then the results should be checked scrupulously.

When we think of self-consciousness as a scientific assignment in neuroscience, then we are supposed to investigate objectively the phenomenon whose nature is extremely subjective. By now, the only access has been found in reduction of self-consciousness to elements encompassed in self-conscious experience. These elements might be activities such as perception, memory, emotion, volitional movement [37], equalizing them with self-consciousness itself. More sophisticated elements of self-conscious experience, such as self, thinking (ideation), making decisions, free will, integration of past-present-future experiences, or moral feelings are put aside.

By reducing this complex phenomenon to its simpler component elements it leads us to a possibility to think of one's *identity as self-consciousness* itself.

8.1 Identification in mirror

For us it is very easy to recognize ourselves in a photograph. We are approximately aware about our own image. If a stain is painted on our face, and we look at the mirror, we become aware without delay that it is not a part of our normal portrait. No one living creature except man can do that. Even a chimpanzee hardly can recognize himself in the mirror, and not to talk of small cosmetic details, an this was result of Gallups studies [39].

8.2 Identification problem and the split brain

Sperry is the unavoidable name when speaking of brain-mind relationships, splitting brain and hemisphere specialization (cf. Fig. 8) and so it is when we reduce self-consciousness to selfidentification problem [40-43].

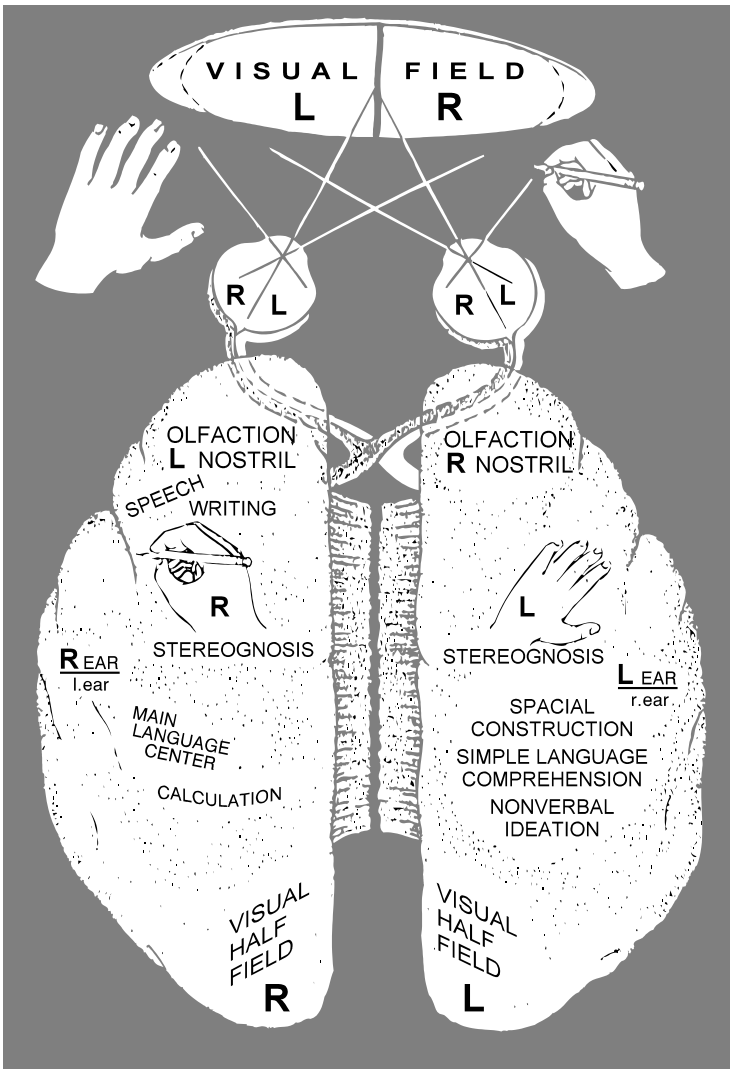

Figure 8 *Brain specialization and self-consciousness.* Diagram illustrating hemisphere specialization. It is supposed that self-consciousness is mostly situated in the major, left hemisphere. Note that cut of corpus callosum, and relationship between visual fields and hemispheres, contra and ispilateral.

There are reasons to think about self-consciousness as localized brain function, as Broca or Wernicke speech centers are localized, for instance. It is believed the dominant, verbal and logical left hemisphere to be the main site of self-consciousness, though it might be more appropriate to consider such an integrative mental result to depend on nonseparated communication between both intact hemispheres. Nevertheless, verbally skilled left isolated hemisphere is leading as selfrecognition hemisphere.

But Sperry has brought some evidence that the right hemisphere has its own ability of selfrecognition, though verbally almost mute.

From some parts of the visual field, under convenient arrangements (one eye closed, and visual stimulus or object positioned in a particular segment of the visual field) pictures can go only to one hemisphere, though chiasma is not transsected. Only transcallosal communication between hemispheres is broken.

So, after postoperative section of corpus callosum, it is possible to offer one's own photograph to only one hemisphere for recognition. The left, major and dominant hemisphere recognizes all details explicitly. When a personal photograph is offered to the right, minor hemisphere from the left segment of the visual field, adequate emotional reactions accompanying the act of recognition doubtlessly prove that the right hemisphere preserves at least rudimentary ability of selfrecognition, as a correlate of self-consciousness [43].

But some objections are unsolved - subcortical weak commissural connections still are present, though the main major interhemispheric commissure is transsected. This questions self-conscious autonomy of the right, minor hemisphere.

9. CONSCIOUS INTENTION AND VOLUNTARY ATTENTION

In the last three decades some electrophysiologic correlates of subjective mental states were discovered and we are going to discuss them.

Self-consciousness and will are basic human mental features, beside the ability to symbolize, and because of these three properties human being is essentially different from all the rest of living creatures on the planet.

Will as a process encompasses three phases: motive struggle, making a decision and carrying out a decision. Will includes making conscious decision and consciously carrying it out. Within a willful act there is the state of deliberate and *conscious intention* and it speaks by itself of existence of the specific quality of consciousness which we designate - self-consciousness. Neurophysiologic exploration of entirely subjective phenomena (objectively non measurable), such as willful intention, in which only by introspective method we can get insight -

discovered exciting indicators, electrical potentials (objectively measurable) in correlation with subjective mental events.

Suppression of α–activity by opened eyes in daylight or lighted room is a well known test in electroencephalography confirming that we deal really with α–spindles [44], and not with μ–rhythm. Now we understand that fragile α–synchronization is not only a consequence of optical stimulation. That may have a far reaching meaning which can be proved by the following experimental manipulations:

(i) Deprived of light, the subject is in a completely *dark* room with eyes *opened*: α–rhythm is normally registered. Alpha rhythm vanishes if the subject is asked to try to see something despite darkness. It means that mental effort within willful intention suppressed α–activity, without any other source of activation (movement, stress, sensory or emotional).

(ii) If the subject is in a *lighted* room with eyes *opened* in front of a monotonous, unstructured surface sitting for a while, α–rhythm reappears. It justifies the surmise that attention activation is the basic reason for disappearance of α–activity, and not visual stimulation of neocortex per se.

(iii) *Einstein* [44] performed some mathematical operations, he was actively calculating, but α–activity was registered permanently. Only when he found a mistake in his calculations α–rhythm disappeared.

We might suppose α–blockade to be correlate of conscious and willful attention.

Cognitive N150 and P400 from SSEP complex and Desmedt's very intriguing experiments we have already discussed to some extent. Now we are going to add a few more very interesting details.

It has been shown that amplitudes of both N140 and P400, especially P400 were dependent on attention intensity. When the number of stimulus impulses increased from 40 to 150 per minute, correspondingly their amplitudes heightened (the subject was asked to count impulses).

When the subject was asked to sense very weak stimulation, N140 and P400 amplitudes magnified as well, again more conspicuous was the P400 change. These experiments suggest that there exists a strong correlation between the intensity of invested conscious and voluntary effort and of the N140 - P400.

In Fig. 9 (B) and (E) traces are registered contralaterally, and in (C) and (F) ipsilaterally. Only thicker lines in (B) and (C) represent in a way repeated experiment already seen in Fig. 7. The subject was told to pay attention to his third finger, and this finger, target finger was actually stimulated. Only then N140 and P400 were well depicted bilaterally, P400 symmetrically and N140 asymmetrically,

with lower amplitudes ipsilaterally. Stimulation with full voluntary attention centered to the stimulated finger depicted conspicuously well symmetrical P400.

In all other experimental task variations the subject was "cheated" - he had to pay his attention to in fact a non stimulated finger. The finger which was indeed stimulated was either on the same or opposite hand. A global conclusion is evident: in all these "deceiving" situations specific N1 and P1 were regularly registered contra and ipsilaterally, as an evidence of normal perception of sensation in elementary primary somatosensory zones. But N140 was diminished or absent, and P400 was regularly absent.

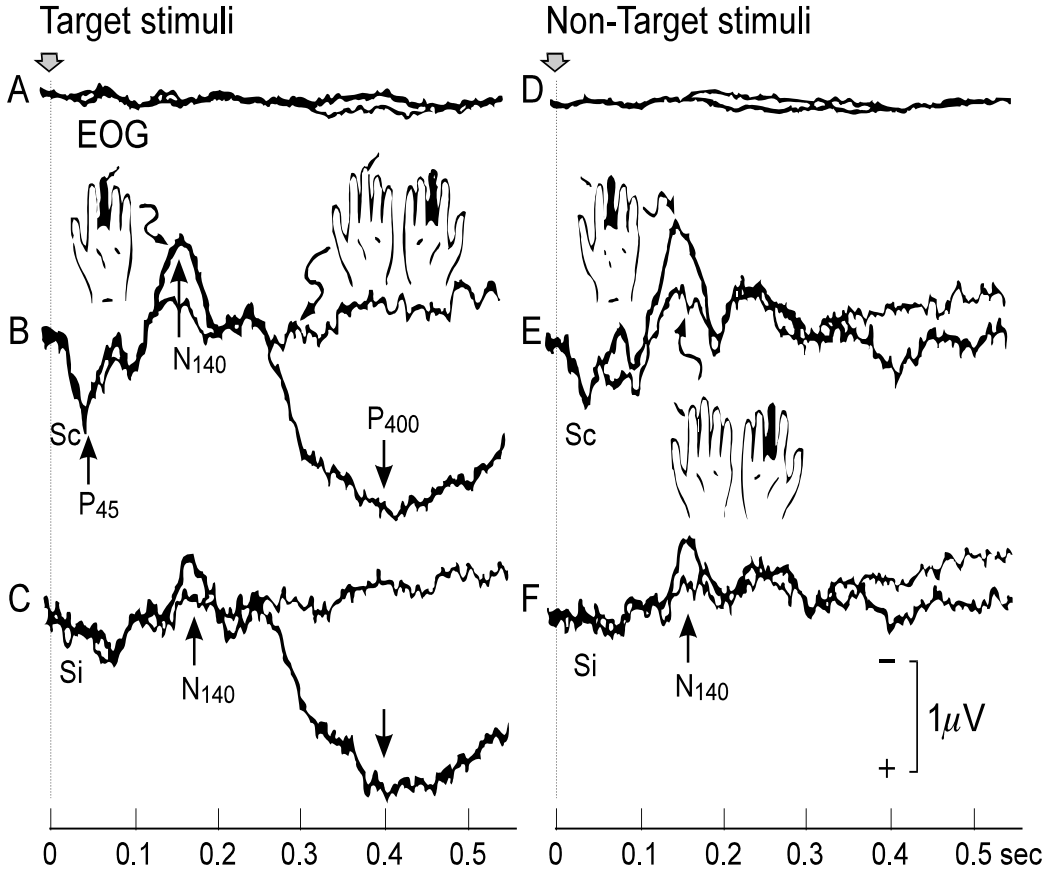

Figure 9 *Correlates of willful attention: P400 and N140.* There are Figs. 9 (B), (C), (E), and (F). Figs. 9 (C) and (F) represent ipsilateral registrations. We can see only two traces with clearly formed P400, both contralaterally (B) and ispilaterally (C). These traces are correlated with paid attention to the stimulated finger. Whenever, in all other combinations, attention was directed in wrong direction - to nonstimulated finger - in registered evoked potential the complex wave P400 missed entirely. (For more detailed comments see the text)

It should be noticed that primary and specific EP is asymmetrical: amplitudes are much higher contralaterally, but P400 when present is symmetrical bicortically. Also, EP early components are localized *only* in primary sensory cortical zones, and EP late components spread over bifrontal and biparietal lobes, the highest amplitudes over parietal lobes. To originate specific part of EP, a very narrow strip of neocortex is necessary. Transformation of one modality into nerve impulse and cortical event is a much less elaborate process than creation of self-consciousness. But generation of N140 and especially P400 need wide neocortical areas, as for somatosensory self-conscious perception as many as three lobes are involved. This is in acordance with self-consciousness, bringing definitely a new quality to perception process.

9.1 Conscious-volitional intention and three negative surface potentials

Willful act is made possible by focus of awareness, or attention. Attention is both a turning point and a connection between awareness as non specific general state of CNS readiness, and self-consciousness as integrated result of all mental events-processes, with emphasis on "knowledge" concerning contents incorporated in consciousness. The very attention means *choice*, and intentional attention means *volitional and conscious choice, or selection*. We can think of attention as a required precondition for self-consciousness, but also as a part of self-consciousness itself. Anyhow, the final phase of will process assumes the decision to be carried out, and the prerequisite for it is conscious intentional attention.

By now three electrical phenomena - three different types of negative waves - are registered from the scalp, having to do with volitional attention and very subjective mental state i.e. *intention.* These are: *contingent negative variation, readiness negative potential,* and *negative potential of goal directed movement.*

(1) *Contingent negative variation is expectancy wave* (cf. Fig. 10) [45-47]. During conditioning procedure subject is asked to pay attention to auditive signal after which he should expect following visual stimulation (flickering e.g.). His task is to stop visual stimulation by pressing a button immediately.

Between two signals arises negative, longlasting potential, and it can be registered over frontal regions and, much less prominent over parietal regions. Unless reinforced, it extinguishes rather quickly. This negative potential is independent of motor response. It is registered exactly in the same fashion in experimental animals, so it should be appraised as a correlate of attention.

(2) *Readiness potential* (cf. Fig. 11) is electrophysiologic correlate of willful intention to perform voluntary movement, movement under free will control. The subject chooses freely when to move his finger. All the time brain activity is registered and stored in the computer. When voluntary movement elicits muscle

potentials through EMG, these muscle potentials trigger the computer to analyze stored electrical potentials backwardly, potentials being registered before movement did happen. And this analyze revealed gradually building negative potential with onset about two seconds *before voluntary movement* shall take place [49,50].

These negative potentials are registered almost symmetrically with highest amplitudes over parietal lobes and considerably lower over prefrontal regions, and asymmetrically higher contralaterally.

Readiness potential originates in the course of a very subjective mental situation - when a subject *prepares intentionally* to make voluntary movement. *It is correlate of intention to perform motor act* which actually did not happen, but will happen in the near future.

Here, we should refer to the results of *radioactive isotopes* distribution, which show the increased blood circulation in specific motor zone, supplementary motor zones, postcentral gyrus, and prefrontal lobe - when a subject forms intention to move his hand, *only imagining* the movement.

Prefrontal activation is noticed in contingent negative variation studies too, and these facts suggest the significance of prefrontal lobes for producing volitional attention, for conscious and willful intention. So it is understandable why prefrontal leukotomy abolished formation of aggressive *intentions* in dangerous psychotic patients.

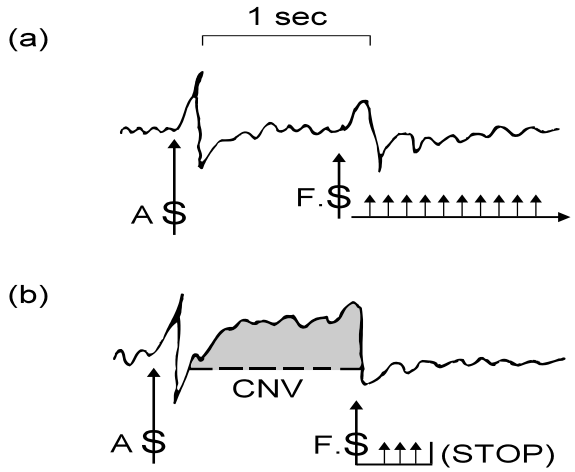

Figure 10 *Contingent negative variation (CNV), or expectancy wave:* (a) Auditive signal and flickering stimulation are registered, and between them nothing happened - oscillations were about base line; (b) Between two identical signals as in Fig. 10 (a), appeared rather large negative potential. The only difference in experimental procedure was that subject knew that after sound visual signal would come, and he had assignment immediately to stop flickering by pressing a button. During expectancy period, psychological state of ready conscious attention had this negative potential for electrophysiological correlate.

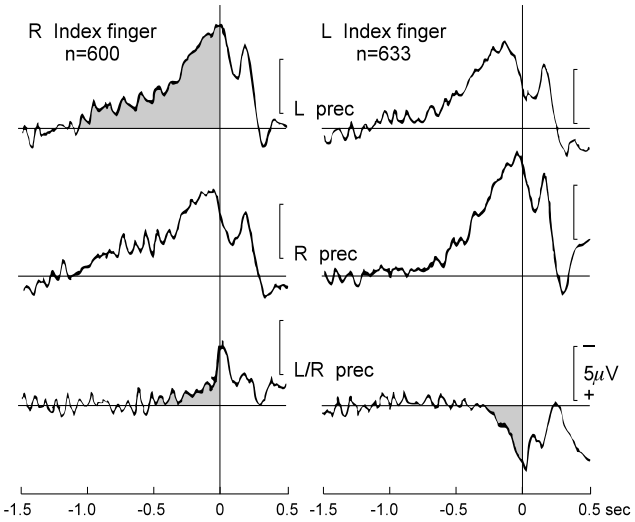

Figure 11 *Readiness potential.* Experimental procedure is summarized in the text. Four upper curves are registered monopolary, and two bottom traces bipolary. The subject absolutely freely makes decision when to move his finger. About two seconds before movement a negative potential commences to build up amplitude with its maximum at the very moment when muscle contraction starts. Negative potentials are higher contralaterally which means: for right index finger it is over left precentral zone, and for left index it is over right precentral zone. Bipolar traces registered voltage difference between ipsi and contralateral precentral zones demonstrating contralateral potentials always to be higher.

(3) *Negative potential during goal directed movement* (cf. Fig. 12) is a negative wave registered during voluntary movement to a specified target. It is registered as continuation of the readiness potential, after goal directed movement set going, and it persists until the movement terminates [51]. Negativity is located bilaterally over parietal and prefrontal lobes with amplitudes twice as big as the readiness potential.

There is some evidence that near Brodmann area 24, slightly more frontally, a sort of "center" for integration of free will is situated. Anyhow, this is the place where free will may be easily damaged [87, 88]. Area 24 belongs to limbic brain, emotional brain and this is our next topic - emotions and self-consciousness.

10. SELF-CONSCIOUSNESS AND EMOTIONS

Emotions accompany all our experiences throughout our lives, ever changing as reactions or moods. We are not only feeling them in our subjective inner world,

we *know* [1] that we feel them, and by definition it is a portion of self-consciousness.

Beside this subjective and specific feeling it is possible to discern three more characteristics of any emotion:

(i) this feature is already mentioned: *subjective and specific experience* concerning emotional attitude is accessible only by introspection (immeasurable feature);
(ii) *cognitive* aspect (to have an emotional attitude toward something, it must first be perceived and understood afterwards; or revived from memory);
(iii) *expression* through behavior (ethology) and vegetative functions (physiology); observable objectively;
(iv) *excitation* - general (AARS), non specific.

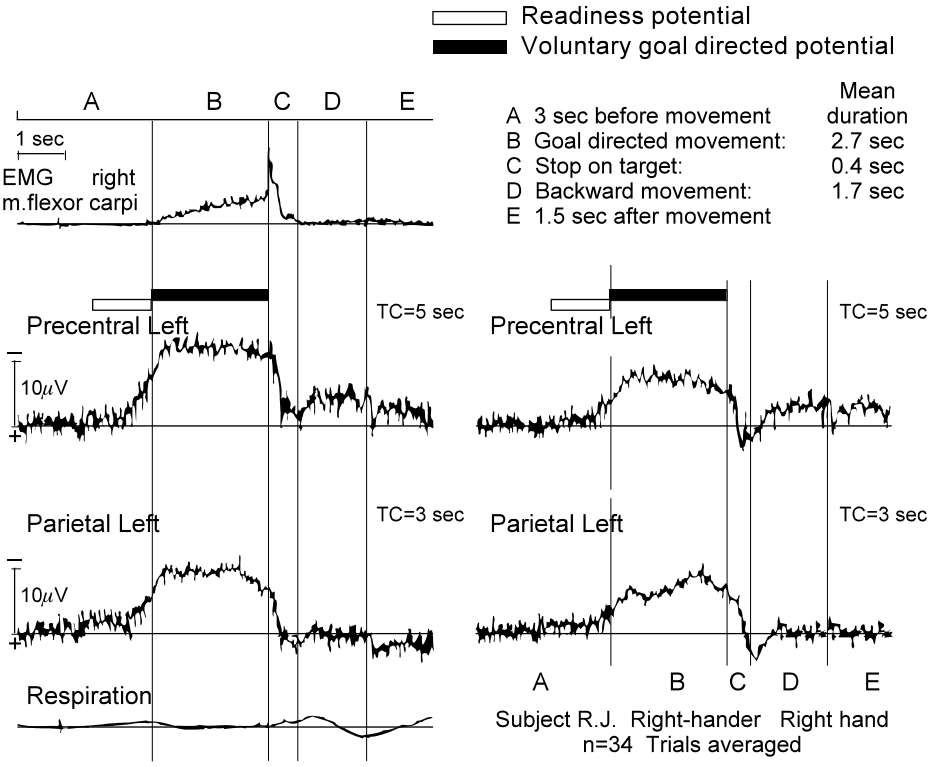

Figure 12 *Negative potential of voluntary goal directed movement.* This surface negative potential is continuation of readiness potential. The readiness potential is premovement correlate of free will, while the voluntary goal directed potential is correlate of free will during the movement. Notice twice as high potential (in section B) as readiness potential (in section A). These potentials are almost symmetrical ipsi- and contralaterally, slightly lower ipsilaterally. They are diffusely registered precentrally and parietally, lower parietally.

Evidently, the most important, the most conspicuous features of any emotion are its subjectivity and the specificity, or - specificity experienced only subjectively. We generate a wide span of emotions, with elaborate, lavish hues and often very complex meanings because of simultaneous attitudes mutually excluding each other.

But the simplest division makes difference between two antithetic groups of emotions: *pleasant-unpleasant* (or: agreeable-disagreeable / aversive-affiliative / positive-negative) which in its ends means love-hatred / creation-destruction / life-death.

Clinical routine tutors that perception can be disintegrated immediately after registered elementary sensation. Connections with previous experiences - the knowledge giving meaning to sensation can not be established. If it happens, patient reports registered sensation, but he does not know its meaning. In other situation, only the name may be lost like in nominal aphasia.

Similar disintegration of the emotion complex in its four constituent parts might be observed as well. The essence of emotion is hidden under the question whether it is *pleasant* or *unpleasant*. And this coloring can be removed from complex of total emotion, the other elements not being disordered. For instance, after prefrontal *leukotomy* [52,53], or right parietal lobe lesion, *pain* is perceived but *the component of unpleasant* suffering disappears. The emotional attitude toward pain vanished. So does motivational influence of suffering on behavior: no reaction. When discussing prefrontal leukotomy results, we should not neglect the role of prefrontal lobes in connection with already mentioned organization of willful intention activity and willful attention and their influence in organizing behavior.

Similar splitting we can find in the *sham rage* [53,54]: expression of emotion is preserved, but not emotional attitude. (False emotion does not influence current activity, they are parallel phenomena, because such emotion does not motivate to behavior modification; it does not last longer than stimulus; and emotion is not directed to anything or anybody - these are some of the main properties of sham rage). These and similar indications document reality and justify division of emotion in four constituent elements.

Biologically, emotions are mediated by (1) limbic system, (2) hypothalamus and (3) two brainstem opponent systems: cholinergic (periventricular) aversive system and monoaminergic pleasure (affiliative) system with medial forebrain bundle (MFB). But this is not the whole truth, this is only the strictest, minimal structural nucleus for emotion production. In reality, the total nevrax is engaged in any emotion. For instance, cognition is one of the four elements of any observed emotion. And for good cognition it is relevant how intelligent a person is and what experience has at his/her disposal. And for intellectual operations, the whole telencephalon is necessary, both hemispheres with all cortex and subcortical structures; or to transform emotional motivation into behavior it is vital to have coordinated muscle activity, and this is not possible without cerebellum,

extrapyramidal system, reticular stem system and final common path in brainstem and medulla spinalis. Furthermore, the whole organism in any emotion is engaged: with cardiovascular, respiratory functions, endocrine and autonomous nervous system in order the fundamental functions to regulate properly.

What is separated represents only the anatomical core of emotional life.

Limbic system (emotional brain) consists of cortical and subcortical structures, and connections [55], cf. Fig. 13. There are *two cortical* rings situated on medial sides of hemispheres. They are looking at each other like face at its image in mirror.

Outer ring is younger sixlayer mesopalium, with synonym paleopalium (gyr. cinguli, 23 and 24 Brodman areas); and inner ring is older three layer archipalium (gyr. dentatus, induseum griseum, hippocampus). *Subcortical nuclei* comprise: septal nuclei and amygdala nuclei. The strongest *connection* in limbic system is fornix.

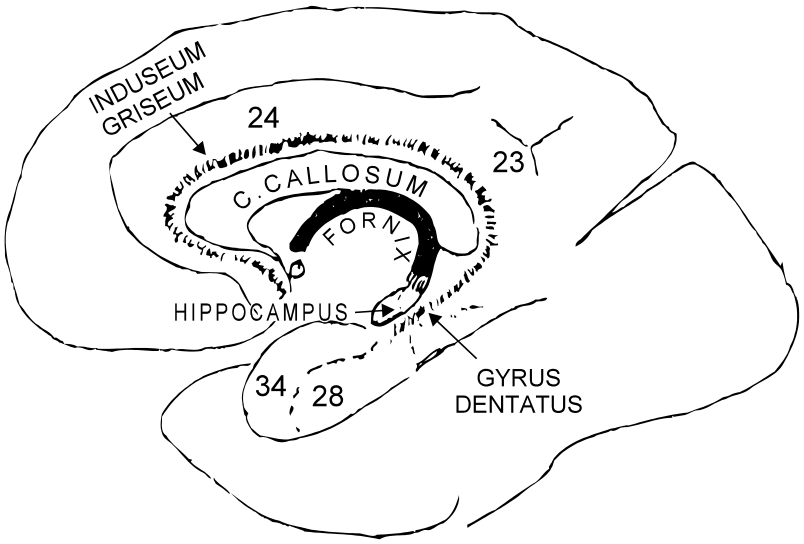

Figure 13 *Limbic system.* Limbic system consists of limbic cortex (two rings), subcortical nuclei (septal and amygdalar) and connections (fornix). Outer sixlayer ring or mesopalium (paleopalium) comprises: Brodman zones 23 and 24 making gyrus cinguli, isthmus gyri cinguli, gyrus parahippocampalis ending as uncus gyri parahippocampalis (Brodman 34) and enthorinal cortex (Brodman 28). Inner ring is less developed three layer archipalium which embodies: induseum griseum, gyrus dentatus and hippocampus.

Three monoamins - two catecholamines (Noradrenalin-NA; dopamine-DA) and serotonin-5HT - are the main neurotransmitters in limbic system and in hypothalamus. NA (main noradrenergic source-locus coeruleus) and DA (main dopaminergic source substantia nigra) mostly mediate aggression, selfstimulation (septal region and MFB), emotions, arousal (AARS) and feeding. 5HT (main serotonergic source-raphe nuclei) mediates opposite functions: relaxation and sleep.

Obviously, this does not mean that other neurotransmitters have nothing to do with limbic system and hypothalamus, especially cholinergic system as we are going to evidence.

Papez [44,56] was among the first to sketch integrative conception of mechanisms generating emotions and to propose scheme of it. Concerning the substrate of emotion origin he shifted the place of highest control and integration from hypothalamus [57,58] to gyrus cinguli, a part of mesopalium. With Mac Leans [59] improvements it did not lose its value.

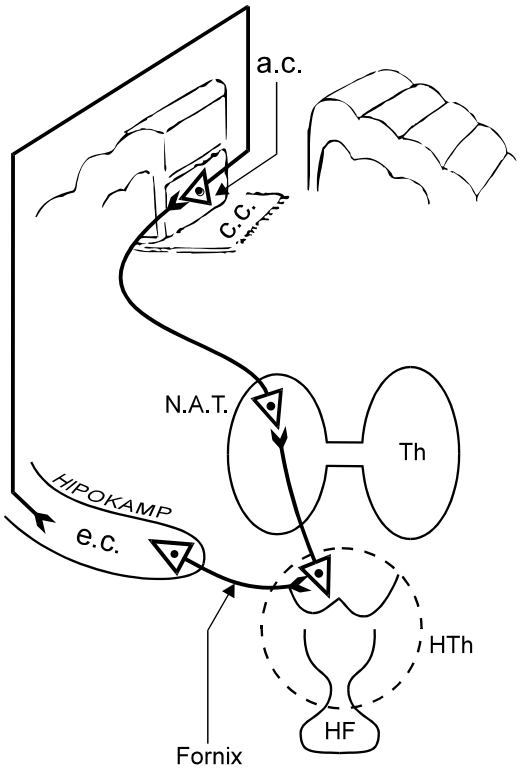

Figure 14 *Papez's circuitry.* This construct describes connections among limbic cortical structures, hypothalamus and nucleus anterior thalami. Abbreviations: c.c. - corpus callosum; g.c. - gyrus cinguli; e.c. - enthorinal cortex; Hth - hypothalamus; HF - hypophysis; Th - thalamus; NAT - nucleus anterior thalami; (see the text).

Papez proposed the circle (cf. Fig. 14) which could primarily explain expression of emotion (through preformed patterns in hypothalamus; hypothalamus in connection with hypophysis). After increased knowledge about the role of hippocampus in memory process [60-62] which is through fornix connected with mammilary bodies, part of hypothalamus (behavior patterns, endocrinology, ANS), and by tractus mammilothalamicus hypothalamus is connected with nucleus anterior thalami (belonging to archithalamus - attention), this construct became refreshed and

refined. Via nucleus anterior thalami the system gets its connection with gyrus cinguli (main part of mesopalium, and in hierarchy organization of limbic structures - superior instance overruling hypothalamus); from gyr. cinguli circle is closed because it is connected with entorhinal cortex and hippocampus (memory function, cognitive aspect of emotion), back to hippocampus - to the starting point of circle.

As already has been said, Mac Lean changed Papez circle to some extent. He diminished significance of gyr. cinguli, and introduced septal and amygdala nuclei complexes.

Septal region was already mentioned in Papez original construct. But now we can think of septal region quite differently. First, it is now known that septum pellucidum is not empty membrane: instead it contains small agglomerations of nerve cells - nuclei. And these nuclei have got extremely important functions. They are part of substrate of pleasant emotions, of hedonic system which also includes monoaminergic MFB from brainstem.

On the other hand, *medial septal nucleus is pace maker* [63] *in producing hippocampal 7.7 Hz activity* when all other parts of brain are desynchronized [63,64], and it has to do with memorizing, consolidation and reviving engrams. Furthermore, we know that for memory function hippocampus plays crucial role, but only in interplay with septal nuclei. Septal nuclei are connected with hypothalamus - the source of behavior patterns (fight/ flight, avoid/approach).

Septal region should be presented also in the light of its role in *stress and anxiety*. Medial septal nucleus has rich input from reticular stem system - noradrenergic and serotonergic parts. When stimulated by them, electrical activity of brain becomes very similar with the brain of an animal exploring its environment while it is for it new, uncertain and to some extent perilous in which it learns - and generalized desynchronization is registered, except in hippocampus. The very moment it stops exploratory behavior, hippocampus turns to be desynchronized too.

Gray [65] proposed neuroanatomic and neurophysiologic core of *anxiety to be in septo-hippocampal* complex, receiving rich serotonergic [66] and noradrenrgic input from reticular stem substance. Whenever an animal is in stress and anxiety, reticular system stimulates septo-hippocampal region coming with it in first touch via medial septal nucleus, and through A10 dopaminergic nucleus simultaneously stimulates only DA system giving input to prefrontal region [53,66-68] which is not of special interest for our topic.

Amygdala nuclei are substrate of unpleasant (negative, aggressive) emotions. When directly stimulated, amygdala regions give aversive responses almost always. Corticomedial nucleus of amygdala is connected with hypothalamic nucleus dorsomedialis by stria terminalis making subsystem for expressing aggressive behavior, with the opposition role (inhibition of aggression) of hypothalamic nucleus ventromedialis [69-71], inhibitor of aggressive behavior.

In a short summary: it is supposed the *amygdala* complex to mediate *selfpreservation* motivation; and *septal complex to be organic basis of species preservation and sexuality.*

By introducing septal and amygdala complex into limbic system Mac Lean widely opened a door for two stem systems to be included in Papez construct, as bearers of two opposite groups of emotion - pleasant/unpleasant. In brain stem there are two *opposing systems: cholinergic periventricular (PVH) - aversive system (fibers collected in dorsal and ventral bundles), and monoaminergic MFB (containing noradrenergic and serotonergic neurons mostly, plus dopaminergic neurons in mesolimbic bundle, and to some extent nigrostrial DA system) - pleasure system*.

These two systems, either on stem level or on subcortical limbic nuclei level, are opponents likewise *sympathetic and parasympathetic subsystems of autonomous nervous system.* But these two stem subsystems - PVH:MFB (or amygdala:septal region) are concerned with suffering and pleasure, which means with emotions and motivation. Opposing roles demonstrate ablation experiments: after septal region is removed the animal becomes aggressive, very irritable; contrary to bilateral ablation of amygdalae - when the animal turns to be tamed and hypersexual. But it seems that both septal and amygdala systems perform their activities by stimulating and controlling embedded patterns of behavior in hypothalamus.

In 1954 Olds and Milner [72-76] placed stimulating electrodes into the brainstem structure what we call today MFB, and found that the experimental animals liked MFB stimulation more than any other activity bringing pleasure to it (food, water, sex etc.). They would suffer pain or electric shock only to get access to the stimulation device. Later, it was discovered that stimulation of septal region gave the same result: animals selfstimulated its brain up to 7 000 times per one hour. The same system is verified in human brain. Electrodes were implanted in the septal region of some schizophrenic patients. They preferred selfstimulation which were very pleasant with some hues of sexuality. So *pleasure system* was established in human brain as well [77,78].

Cholinergic system mediates aversive behavior. Direct stimulation of cholinergic system stops current behavior. It provokes unpleasant sensations, and quite opposite to direct stimulation of MFB it discourages current behavior. Direct stimulation of cholinergic system may be used in experiments as non conditioned aversive stimulus, and it can be used in conditioning learning procedures as well. As we have seen, monoaminergic system (NA) mediates arousal, excitation. Cholinergic system mediates inhibition (through habituation, extinction of conditioned responses). Cholinergic system inhibits behavior endangering life, diminishing chances for survival. Also it mediates water balance and *aggression*. Generally, cholinergic system has to do with selfpreservation, as well as amygdala complex (made mostly of cholinoceptive neurons).

There are two cholinergic paths - dorsal and ventral [79-83]. Periventricular dorsal cholinergic bundle starts from dorsal part of mesencephalon, then caudal and medial parts of hypothalamus and thalamus. Projections are going into limbic brain. Direct stimulation of this system abolishes learned responses.

Ventral cholinergic bundle (originating from substantia nigra, subthalamus, hypothalamus) ends, among other destinations, into limbic cortex and medial septum. After synaptical breakage in medial septal neurons, these now septal cholinergic neurons project into hippocampus. Hippocampus is an important cholinergic crossroad [84].

Before we summarize possible neuroanatomy of self-consciousnes of emotions, let us first summarize elements of system mediating cognition taking part in genesis of emotions. We already talked about hippocampus and memory. Through neothalamic nuclei the limbic system has rich communication with associative neocortex necessary for cognitive processing of the input information. Between neopalium and mesopalium rich direct connections are also verified.

Memory mechanism is deeply interwoven in limbic system involving hippocampus, parahippocampal region with enthorinal cortex and fornix (cf. Fig. 15). Biologically it is rational arrangement. The more important experience for survival, the more emotional event it is. So the process of remembering should be proportional to elicited emotion. Evaluation of a new situation depends on the past experience and judgment of new circumstances. After cognition which includes its meaning and value in our personal value system, our emotions will be formed, motivating our behavior. Anatomically it seems to rely upon connections among: gyr. cinguli - gyr. parahippocampalis - hippocampus - mammilary bodies - nucl. anterior thalami - and back to gyr. cinguli, thus making main brain circle for memorizing life experience.

We already talked about septal and amygdala inputs to nucl. dorsomedialis thalami, one of three neothalamic nuclei, which projects into prefrontal association area of telencephalon. Association areas are prefrontal, parietal and temporal with very strong interconnections between neocortical vertical units and thalamus, and cortico-cortical associations: within the same hemisphere (ipsilateral), and contralateral through commissures, mainly corpus callosum. Sir John Eccles proposed more complete explanation of cortical memory mechanism. Coding engrams by spatiotemporal organization of neuronal activity seems to be widely accepted as well as changes of synaptic membrane grid [85]. The process of coding depends on a sort of spatial summation of vertical inputs from inside vertical unit ("cartridge" excitation) in conjunction with inputs coming from commissural, associative and Martinoti axons forming densely packed horizontal first and second cortical mostly fiber layers. The most interesting part of the hypothesis is that the cartridge input is initiated by hippocampus [86] (which is, as we know, directly influenced by stress, distress, arousal, excitation).

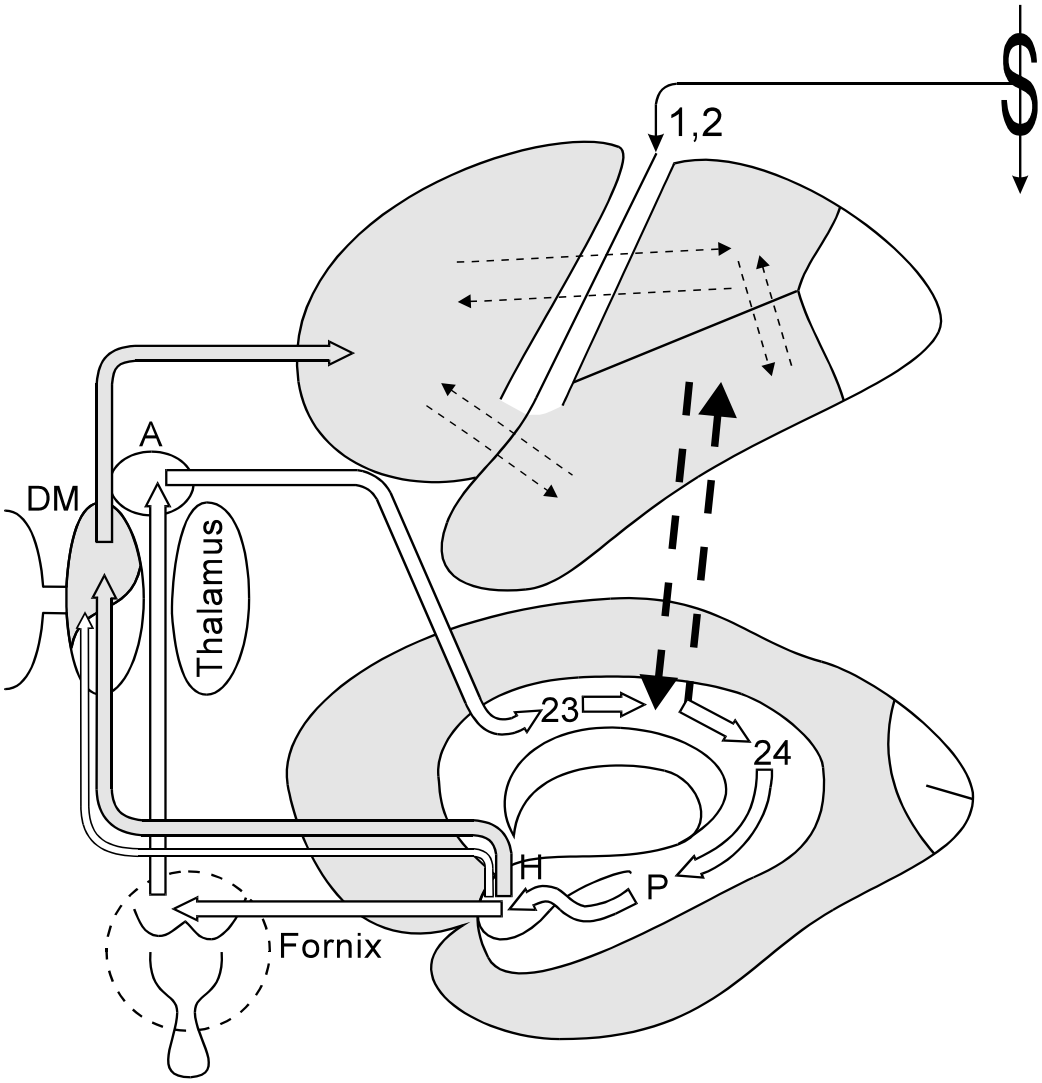

Figure 15 *Memory, hippocampus and self-consciousness.* Shaded associational neocortex and neothalamic nucleus dorsommedialis suggest organic substratum for self-consciousness on cognitive aspect of emotions, as well as interplay between these structures and main memory site - hippocampus. Rich interconnections between prefrontal, and greatest parts of parietal and temporal lobes on one hand, with limbic cortex on the other, prepare the brain basis for self-consciousnes regarding emotions. And outstanding position of hippocampus in this circuitry gives rise to hypotheses why we not only feel, but we are conscious - we know that we feel. Abbreviations: H - hippocampus; P - gyrus parahippocampalis; 23,24 - gyr. cinguli; DM - dorsomedial thalamic nucleus; A - nucleus anterior thalami; 1,2 - Brodman zones of somatic sensibility.

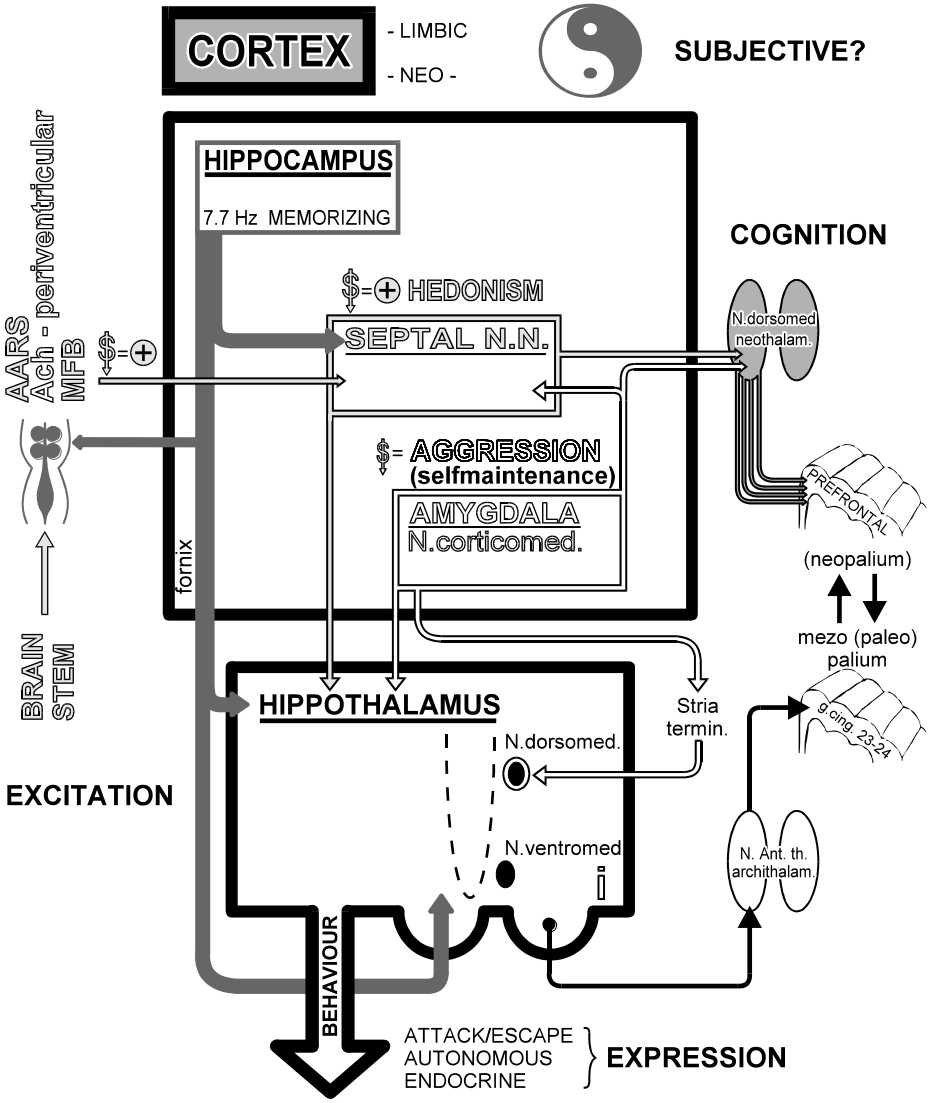

Figure 16 *Brain basis of emotion, and self-consciousness of emotion.* This scheme offers an integrative model of brain foundation of four emotional aspects and self-consciousness regarding emotional experience. Center of the scheme consists of two frameworks: bigger consists of three subsystems: (1) hippocampus (memory function); (2) septal system (hedonism) and (3) amygdala system (aggression). The last two subsystems are organic basis for dividing emotions in two opposed groups - each with *specific and subjective* imprint as pleasant or unpleasant emotions. Periventricular cholinergic and monoaminergic MFB of brain stem belong to pleasant/unpleasant organization centered on septal and amygdala nuclei. *Expression* goes through hypothalamus. *Cognitive* aspect of emotion has to do with hippocampus, and through nucleus dorsomedialis with wide associational neocortical zones. *Excitation* is connected with AARS of brain stem. *Basis for self-consciousness* as an integrative phenomenon might be seen in interplay between dorsomedial nucleus and associational neocortex (e.g. prefrontal cortex) with mesopalium as exponent of limbic emotional brain. All these structures receive abundant inputs and send outputs taking part in the final integrative result - self-consciousness.

Now, in general we can present brain basis for all four aspects of emotion (cf. Fig. 16):

(i) Subjective-specific emotional color (*septal nuclei + monoaminergic MFB* : *amygdala nuclei + PVH bundles*);

(ii) Cognition (hippocampus, via neothalamus-association areas of neocortex: pre-frontal, parietal, temporal and direct cortico-cortical communication between association neocortex and limbic mesocortex);

(iii) Expression (through hypothalamus: behavior patterns, VNS, endocrine glands);

(iv) Excitation (AARS and archithalamus).

Nucleus dorsomedialis has crucial role in forming self-consciousness, because of inputs coming from pleasure (hedonic) system from septal nuclei, as well as from amygdala, the basis of unpleasant aversive emotions. Direct and indirect inputs from hippocampus also come to nucl. dosomedialis, bringing necessary cognitive component in the emotion integration.

Nucleus dorsomedialis and neocortical association zones were also of the topmost interest when we talked about the memory mechanisms, with its anatomy deeply interwoven into emotional brain. These structures could be crucial also for self-consciousnes, that *specific knowledge of our own experiences* being self observed by us as some neutral phenomena outside our subjective space or personality. Attention could be only the trigger of conscious relationship toward ourselves.

11. ON HYPOTHETIC NEURONAL ORGANIZATION OF CONSCIOUSNESS AS "KNOWLEDGE"

It seems that the crucial phenomenon which defines consciousness and specific part of it - self consciousness is the state of - "knowledge".

Unless it is unconscious, any activity concerning oneself (cognitive, conative or orientation) goes hand in hand with "knowledge" that the activity is going on, or is done. What is the brain substrate, neuronal setting of the phenomenon, is a very difficult question, and science is not ready to answer it reliably, at the present moment.

Anyhow, Crick (1994) proposed previously to answer "easier" problem: how through perception processes different features of one object become integrated as one object. It is supposed that behind synchronously perceived different features of an object lies activation of neuronal settings in different and often distant parts of brain. This timing of neuronal settings activity brings them into union, so that separate characteristics vanish in holistic impression of oneness.

Synchrony is only one of supposed prerequisites of the magic "knowledge". Abundant feedback connections among all levels where computation is interchanged through reentrant information feeding make vast net of reverberatory excitatory/ inhibitory processes being the part of computation.

Hierarchical organization of nervous system is rather an old hypothesis, and it is part of evolution theory. Looking globally, brain regions are hierarchically organized, lower and more primitive are under control and integrated in younger and more developed. The newer in this concept is that even in one region there exist local levels of hierarchical organization. Lower level passes its result of computation on for further and more sophisticated elaboration to higher one, and so in several steps. At least, it seems to be true for visual perception processing in occipital lobes.

Meticulous investigations have given some insight into neuronal structures mediating visual perception and the final result - being aware of it. Talking in terms of perception, man is an optic being. Retinal receptors, relays in corpus geniculatum laterale with additional circuitry including pulvinar and area striata compose neuronal background for very discriminative function of vision, with precise localization all along optical tract and their final representation in area striata (Brodmann area 17), with additional areas 18 and 19, in occipital lobes completely dedicated to one sense - vision. It has been shown [89-91] that area striata cortical neurons columnary organized are specialized to perceive vertical or horizontal lines. Really, they fire action potentials reaching their highest frequency whenever stimulated with the particular position of line. Other positions never elicit maximal firing frequency. Every neuron has its receptive field which is part of total visual field, and neuron is stimulated only from its receptive field. But, its firing is influenced as well by the condition in neighbour receptive fields. The contextual relationship seems to hold true on all levels of brain organization. It brings us to a "projection field" concept [92], which means all population of neurons where an axon branches creating synaptic connections. Many inputs converge on one set of cortical vertical unit, and wide dispersion of its activity reaches many neighbour and distant parts of brain - horizontally (cortically) and vertically (subcortically). Oscillatory circuits exist between cortex and subcortical structures such as: three parts of thalamus, striatum and claustrum [93,94]. So, there is sound reason to suppose that raw stimulus impulse is processed in hierarchically organized neural levels (globally and locally), lower level proceeding the result of its work to higher one where the process is continued until final information is shaped.

At the present moment, hippocampus and enthorinal cortex are under scientific suspicion, almost beyond reasonable doubt, to be "guilty" as crucial structures mediating "knowledge" by harmonious binding rich results of computations in different brain regions organized hierarchically.

Beside being rather a primitive structure, hippocampus is odd in some other aspects, too. For instance, Green and Arduini [48,63] have shown some peculiar hippocampal

characteristics. When brain showed desinchronization everywhere, over hippocampus theta activity was registered. Later, hippocampal tonic and phasic activity has been described and this has been assumed to have connection with memory [95]. Tonic activity is followed by theta rhythm, and phasic correlates with hippocampal desynchronization. Phasic desynchronization lasts parallelly with sensory stimulation, and it dies the very moment sensory stimulation is stopped. So it might be that hippocamp plays central role in consolidation of fresh engrams (theta rhythm) and within phasic activity to be important level of binding perceived different features in total object. Both hippocampal activities might be neural basis of short term memory, being necessary for consciousness, or "knowledge" in higher primates and man. And it is quite reasonable to suppose that short term and long term memory (experience) must have to do with "knowledge" being essential part of consciousness and self-consciousness.

On neuronal level, short term memory might be mediated by functional changes in brain such as excitatory processes in phenomena resembling post tetanic potentiation [84,96], sustained firing of neurons, oscillatory circuits (like neuronal organization in respiratory center, and AARS), and intrinsic properties [97-100]. It is possible that thalamo-cortico-thalamic circuitry (neothalamic nuclei?) may have to do with short term memory and so directly to do with consciousness represented in the phenomenon of "knowledge". So, we might imagine that basic and global activation (facilitation) of cortical units comes from AARS input. Additional energy to selected vertical cortical units, engaged in memory process, comes through archithalamic system of attention. Thus, attention brings two qualities: first - selection and second - strong experience of consciousness. The last two mechanisms might be taken as supportive ones for more sophisticated cortico-thalamo-cortical circuitry activity. And here we can introduce the hypothesis [94] that fifth layer gigantic pyramidal "bursty" neurons are intimately connected with consciousness. They send axons toward thalamic neurons, receiving feedback into cortical layers 4 and 6. The cortical brain areas rich in neuron and synaptic feedback connection content could sustain long-term excitation mediating consciousness experience.

12. A FEW WORDS MORE ON ATTENTION AND SELF-CONSCIOUSNESS

Self-consciousness can be discussed from two points of view: from the aspect of organic organization within the brain work, and from the level of the phenomenon itself. The correlation between two spheres is meager, and far from being clearly and reasonable understood.

Basic biological substrate for self-consciousness constellation ought to be wide associative neocortical regions - prefrontal, parietal and temporal. These neocortical regions rich in mutual feedback connections make them a united functional area. The vast area receives enormous input from elementary sensory and

motor (primary and supplementary) zones, as well as from subcortical levels, i.e. brain stem and subcortical nuclei including thalamus.

Limbic system is a tightly packed part of the whole system both by direct cortico-cortical associative connections (from meso and archipalium to neocortex reciprocally), and from limbic subcortical structures projecting their axons to meso-, paleo- and neocortex.

Nucleus dorsomedialis thalami represents only the most conspicuous vertical connection among cortical vertical units in associative neocortex and subcortical limbic structures, as well as neothalamic neurons functionally binding youngest and most refined level with the evolutionary older and less differentiated one.

Genesis of awareness and self-consciousness depends greatly on the system which converts exogenous into endogenous CNS energy. So two diffuse energetic brain systems with origin in brain stem are of utmost importance: mesocortical part of AARS and its second part whose impulses undergo elaboration in archithalamic nuclei before they outflow into vertical cortical units.

Self-consciousness is always some sort of knowledge. This knowledge is specific because of a unique quality of panoramic regard of oneself and of details composing personal physical and mental design. Once it is a generalized panoramic view, and at another time it concerns a detail - physical or functional (physiologic or mental). Today, it is very hard to assume any knowledge without taking into account the role of hippocampus and its relations with septal structures.

On the phenomenal level we can notice existence of the knowledge of oneself as a whole, and presence of knowledge related to details incorporated as constituent parts of the whole. When we say - detail - we mean functional details at first, the produced operations. Both details and the whole are *experienced par distance*, as if with a new attribute - as if the observer saw himself with another person's eyes, not by his own.

At the same time the experience of identity is neither lost, nor disturbed. Under normal conditions there is no experience of selfalienation. Beside clearly envisioned detail, under circumstances of highly concentrated energy, the connections between detail and the whole become more clearly comprehended, because a detail is never isolated from a system.

So, a better understood detail has as a consequence a more complete vision of the whole, to which the detail belongs. The state of belonging is not lesioned and identity is preserved and enriched with the attitude of criticism. A person recognizes himself as a detail of a greater whole, without losing the sense of his identity. With a bit of exaggeration, we might say that a personality largely reflects and becomes what his attention is focused on.

Self-consciousness *itself* can be observed with explicit knowledge that we have it. We can experience self-consciousness at distance with a suggestion of objective perception, from which limitations originating from oneself and environment turning us into *reactive beings* are removed, at least to some extent. Self-consciousness appears in its full brightness as Venus in the foam of life only if we reject the simplified reactive role. It will not happen unless we define our position as a contemplative one. In the state of self-consciousness details are seen with great clarity including lucid knowledge of what is seen. Then it seems that there exists a causal link between enormous clarity of the observed details, and creation of conveniences for *knowledge at distance*.

A *critical experience* is necessary for a man to have this knowledge at distance for the first time in his life. A critical event has the power of primary revelation accompanied with a feeling of deep delight. Later it becomes the root of critical judgment, as an introduction into individual objectivity when appraising total reality, including the person itself.

With balanced conscience and humane feeling for other people, it opens up a perspective in mankind for humanism which already gave birth to Erasmo of Rotterdam.

Clear vision of a detail entails opening up new perspectives for that detail which always belongs to a larger system. As already said, nothing is isolated, for everything is embedded in a more comprehensive system. That grants an opportunity for development of *knowledge at distance* in regard to one's own self-consciousness, so we might say - *self-consciousness of self-consciousness*. We do not know how many breakthroughs lie in front of us, how many cognitive walls. But that is one of good reasons why life is worth living.

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ALTERED STATES OF CONSCIOUSNESS

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STATES OF CONSCIOUSNESS IN ESOTERIC PRACTICE

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The future belongs to those who can
think beyond the current paradigm

Abstract. This paper argues that the study of the phenomenon of consciousness, and specifically of human states of consciousness, unlike the very recent preoccupation of the Western science with this problem, can be traced back to almost three millennia ago when it was investigated and personally explored by the sages of ancient India, who left behind written documents of their findings, which we know today as the Upanishads. The esoteric lines of other world's major religions have also pursued the investigation of consciousness in their own spiritual traditions as the most important subject-matter of all, arriving at virtually identical experiences and conclusions as the Upanishadic seers as to the nature of consciousness. The paper is focused on a comparative presentation of two esoteric practices which have been most articulate in the description of the results of their research: Upanishads, known under the collective term Vedanta (Hinduism) and esoteric Christianity as taught by a contemporary, venerable Cypriot mystic, simply called Daskalos (teacher). The striking correspondences between these two traditions have been found in all of their aspects, from the macrocosm, the structure of the Universe, to the microcosm, the structure of human selfhood, human bodies, human states of consciousness, and precise techniques for expansion and attainment of higher states of consciousness. Also, a brief comment is made on the psychic phenomena in the esoteric tradition, as well as on the research of these phenomena carried out by Western scientists. Finally, it is maintained that a conscientious implementation of esoteric disciplines and codes of behaviour in the many aspects of human life, personal and social, is the most efficient way for eliminating all evils (wars, crimes, poverty, illnesses, and diseases, unhappiness) that have beset humanity throughout its long history.

Keywords: *Hinduism, esoteric Christianity, mysticism, Brahman, Atman, Absolute, states of consciousness, consciousness, self- consciousness, superconsciousness, superconscious self-awareness, subconscious, selfhood.*

1. INTRODUCTION

Contemporary research into the phenomenon of consciousness has greatly resulted from the mind-boggling findings of quantum mechanics which necessitated vocablary and concepts that were outside the domain of mankind's common, empirical experience. Such knowledge has been possible to express and communicate through mathematical formulas and equations by the specialists initiated in its intricacies, but in verbal descriptions to lay persons they lacked adequate words to present the exotic behavior of subatomic particles. In the whole history of orthodox science until the advent of new

physics the scientists had made their admirable discoveries by using the instrument of mind and intellectual understanding, but aiming at a strict "objectivity" of their knowledge, they had banished the observer and his consciousness which (conscious understanding) made the discoveries possible in the first place! Happily, the experiments related to the investigation of properties of matter and light showed that the presence of the observer is inseparably linked to the phenomena under observation, and thus the observer and his consciousness were readmitted into the field and scope of scientific study.

Another source that has contributed to our growing interest in the scientific inquiry into the subject of consciousness is popularity and easy availability of the "sacred books" of the East, of Eastern phylosophico-religious literature in translations into European languages. Insights into the essence of things arrived at by ancient mystics through their direct experience have shown striking parallels with the latest discoveries of the quantum and relativistic physics. Likewise, latest research carried out by transpersonal psychologists on the theory of personality with their extended concept of man, has been based mainly on the evolved types of consciousness of Eastern yogis, mystics and saints.

A third source that has provided additional motivation for study of consciousness, especially in psychology and social sciences, are experiments by some maverick scientists (in the Sixties and Seventies) with natural psychedelic plants or synthetic drugs which launched the subjects into altered and expanded states of consciousness, proving that there is much more to our normal consciousness than was believed possible.

The objective of this paper is to show that the phenomenon of consciousness as studied in the religious traditions both Eastern in all of the major schools of thought (Hinduism, Buddhism, Confucianism, Taoism, Zen, and Islam in their esoteric aspects) and Western (esoteric Christianity) has been recognized as the most important subject-matter of inquiry and that the mystics have explored and personally experienced all the states of consciousness possible in Reality, and left behind them verbal maps of all realities and relative states of consciousness in which these realities were perceived. Their point of departure was the lowest state of consciousness that we know as an individual's personal ego-consciousness, and through various in-between states, they have arrived at the ultimate state alternatively described as God-consciousness, Cosmic consciousness, Christ-consciousness, or Absolute consciousness.

Unlike technocentric or anthropocentric approach to this problem adopted by modern natural and social sciences, this paper will use a theocentric approach. The terms "religion" and "esoteric" in this context have no theological connotations and have nothing to do with institutionalized forms of any of the world's major religions; it will be used exclusively in the sense meaning "a science of the states of consciousness". The term "mystical" shall mean "a direct experience of reality" or "the art of union with Reality". A "mystic" is "a technician of states of

consciousness", who has through personal effort raised the level and quality of his consciousness to the highest echelon of self-superconsciousness. Also, the words God, Absolute, Reality, Life, or Light, will be used to mean "Absolute superconscious self-awareness".

2. TWO MODES OF KNOWLEDGE

That there are two dominant modes of knowledge was recognized over 2 000 years ago by all of the above mentioned esoteric schools; it is succinctly described in Patanjali's Yoga Sutras [1]:

> I.49 The knowledge which is gained from inference and the study of scriptures is of one kind. But the knowledge which is gained from samadhi is of a much higher order. It goes beyond inference and scriptures.
>
> I.48 In that samadhi, knowledge is said to be "filled with truth";

and about 700 years ago by one of the pioneers of modern science, Roger Bacon, who said, "There are two modes of knowing, those of argument and experience".

The first mode of knowing has been used with spectacular success by Western science in exploration of the outer, physical world. This method is based on observation of natural events through man's five senses, interpreted and conceptualized by powers of his intellectual understanding. The main characteristics of this mode is that it is perceptual, rational, relative, representational, and secular. It provides us with the knowledge we possess about the objects and events in our everyday environment. It is analytic and discursive, based on our intellect whose function is to observe sensory input and then compare, measure, divide, categorize, and describe using pairs of dualities and opposites. It is best epitomized through the abstract mathematical and verbal concepts and symbols, presented in a linear and sequential structure which is typical for our speech and thinking [2]. This mode of scientific knowledge is useful for man's existence - his biological survival and coping with the external, physical world.

The other mode of knowing has been applied with no less spectacular success by religious esoterists in their exploration of the inner world, looking behind the sensory curtain. It is intuitive, cognitive, absolute, and sacral. It is direct experience of reality transcending intellectual thinking and sensory perceptions. It is called absolute, because it is not relied on discriminations, comparisons, abstractions, qualifications and classifications of the intellect which are always relative and approximate. It is empirical experience of undifferentiated, undivided, unqualified "is-ness". However, when described this knowledge becomes relative, because it is translated into ordinary logical language, if that is possible or in so far as it is

possible. Mystical insights can be acquired only through personal experience and not from books and logical reasoning. Esoteric knowledge is needed for our beingness, providing us with sense of our self-identity and meaning of our existence.

The difference between these two modes is vividly portrayed in the following parable: There are two signposts on the roadway, one stating "The Road to the Lectures on Reality" (which is generally taken by the West) and the other, "The Road to Reality" (which is the way of the East). The only way *to study* consciousness is to experience its states directly.

These two modes of knowledge and two modes of consciousness might have their origin in the structure of the human brain, which is divided into two hemispheres connected by a bundle of connecting fibers called the corpus callosum. The right side of the cortex mainly controls the left side of the body, whereas the left side of the cortex controls the right side of the body. These two hemispheres have specialized functions, although both sides share and participate in many activities. Thus in normal persons the left hemisphere is responsible for our verbal, logical, analytic and mathematical faculties. It processes information sequentially in linear time. The right hemisphere is specialized for holistic, integral processing of many inputs simultaneously, for our orientation in space, artistic achievements, recognition of faces, non-verbal ideation. Left side is used predominantly by scientists, philosophers, and writers. Right side is mainly used by visual and spatial artists, musicians, and mystics.

Scientific knowledge is still incomplete, it is still evolving, and it will always be limited by the constraints of our skin-encapsulated ego-consciousness, our five senses and the capacity of the material brain. Mystical knowledge is complete and unlimited, leaving nothing more to be discovered. Science is studying what is comprehensible and understandable, subject to eternal change and thus essentially illusory, Maya; esotericism is studying what is Real, everlasting, unchangeable.

No matter how much we admire the sophistication and the complexity of our material body and our material brains (that handful of earth in our skull), *it is our main obstacle to mystical knowledge, barring out the Reality from us and keeping us in ignorance* [3]. This is what is making human body-ego consciousness, no matter in which degree it expresses itself, to have the illusion of duality, because it is not a reality, the illusion that it is out of the oneness of the Absolute, and creating a kind of separate self from all the other people, and, unfortunately, from the Absolute. Being in the material body we have the feeling that we are different, that we are something not the Absolute, and that we are out of the oneness.

Although Reality is found everywhere we can come in contact with it only in our hearts. Ancient yogis believed that there is an actual center of spiritual consciousness, called the lotus of the heart, which is located between the abdomen and thorax and which can be revealed in deep meditation. The point of convergence between the relative and absolute truth is in the human heart.

3. CONSCIOUSNESS IN ESOTERIC TRADITION

The reality of higher (mystical) states of consciousness has been personally explored and experienced by esoteric practitioners of every religious tradition without exception. In mystical states, utterly different people of entirely different races, in different periods and different religions, learn one and the same thing; hence *in mystical states there is no difference of religions*. All the experiences are absolutely identical; the differences exist only in the language and in the form of description. Although the mystics have raised their consciousness to the highest levels possible and described the dimensions of reality and concepts of the world resulting *directly* from these special states of consciousness, these states cannot be reached *by reason*. Mystical states are verifiable and intelligible only in mystical states; in these states men are able to know what cannot be known in ordinary state of consciousness. Ordinary state of consciousness is only a *particular* type of consciousness and "ordinary" conception of the world is only a *particular* type of perception of the world. All that is possible to get from an intellectual study of mystical states will be merely an approximation, an interpretation, a symbolic description, a tale of Reality and not Reality itself [4].

This esoteric knowledge has been accumulated for several thousands of years and has been handed down from generation of generation within small circles of initiate mystics. This knowledge of all hierarchies of realities and of states of consciousness specific to these realities refers to spheres which have not even been suspected by science, and the techniques and the disciplines leading to mastery of such knowledge are still generally unknown to scientists and mankind at large. However, it can be given only to those who seek, who have been seeking with a certain quality of consciousness, that is with an understanding of how it differs from ordinary knowledge and how it can be found. "The Self is not known through the study of scriptures, nor through subtlety of intellect, nor through much learning; but by him who longs for him is he known. Verily unto him the Self reveals his true being." (Katha Upanishad, 2.23)

As already stated, all major religions of the world possess this esoteric knowledge codified cryptically in their respective sacred books of Hinduism (India), Buddhism (South-East Asia), Taoism (China), Zen (Japan, Korea), Judaism/Kabala (Israel, Jewish diaspora), Christianity (Western World), and Islam/Sufism (Middle East, North Africa). Also, all religions are founded on revelation. Revealed knowledge is proceeding immediately by higher powers from the higher levels of consciousness or from human beings who have attained to these higher levels.

All world's religions can be traced back to their respective single founder, except Hinduism. These historical personages (Confucius, Lao Tzu, Buddha, Moses, Jesus Christ, Mohammed), having attained the highest levels of *superconscious self-awareness*, and tasting the experience of ultimate Reality and knowing their true

nature beyond the identity with their body-ego consciousness, have left behind them maps of their journeys and described the disciplines and preparations needed to be practiced by anyone wishing to reach the same goal.

Acknowledging equal cognitive value of all of the above religious paths, for the sake of brevity and conciseness this paper will limit itself to a comparative presentation of two esoteric traditions, one Eastern and one Western: that of Hinduism and that of Christianity.

"The greatest gift is
the gift of Truth"
(Dhammapada)

3.1 Eastern Legacy - Hinduism

Uniquely among world's major religions Hinduism has no known founder; it is a thoroughly decentralized system with no formal institutional controls. The only allegiance to it is acceptance of the authority of the Vedas, but they require strong individual involvement and their truths have to be verified and proved through personal experience. That is why Hinduism avoids central authority and delegated commitment, its validity has to be tested by time and experience and therefore it knows no dogmas, no religious fanaticism and no heresy.

3.1.1 Vedas and Upanishads: World versus Consciousness

Historians put tentatively the year 2000 B.C. as the time when nomadic tribes called Arya (noble) coming from western Asia began to invade the Indian subcontinent. In the Indus river valley the Aryan invaders encountered a civilization already a thousand years old, with an advanced technology and trade. Fusion of these two cultures created the unique Indian civilization as we know it today. The Aryans brought with themselves their religious beliefs in Sanskrit language canonized in four books of hymns called Vedas - Rig, Sama, Yajur, and Atharva. In addition to the first part of the Vedas which contained the rituals, incantations, chants and offerings related to religious worship, Vedic India also contained rudiments of powerful scientific traditions, especially of mathematics: they developed modern numerals (which we received through the Arabs and thus mistakenly called them Arabic numerals), decimal place system, zero, basic algebra and trigonometry.

The second part of Vedas called Upanishads is not concerned with ceremonial worship and religious rites, but with knowledge of highest reality, of ultimate truth, nature of life and human beings, and of states of consciousness. Although written with brilliant intellectual clarity and conceptual precision, they cannot be compared with Western philosophical or scientific systems based on logic and argument,

because the sages were not builders of systems, but recorders of experience. The Upanishads are *darshanas*, something seen; based on personal experience they are records of inspired teachings of individuals for whom transcendent Reality called God was more real than the world reported to them by their senses. If we want to understand the Upanishads on their own terms, we come up against the rarity of the experience they are attempting to describe. Few human beings have actually seen reality from the perspective taken by these remarkable documents. The "upanishad of the Self" is satyasya satyam, "truth of truth".

Unlike the Vedas which look outward in reverence and awe of the phenomenal world, the Upanishads look inward, *finding the powers of nature only an expression of more awesome powers of human consciousness*. Asking themselves, "By whose mere presence does that desire arise which moves the universe?", the ancient sages found the answer that *that which moves the world is consciousness*, which in human beings becomes, among other functions, *cognition*. That is why the Upanishadic sages showed a unique preoccupation with states of consciousness, focusing on the medium of awareness and of knowing - the mind, a feat unparalleled in the history of any religion or science. They were very keen observers of all phenomena of life and they studied our everyday waking consciousness, dreams, and states of dreamless sleep trying to find out what could be known in each and what faculty could be said to be the knower. What exactly is the difference between a dream and waking experience, both of which contained the sense of "I" of the experiencer? But what happens with that sense of "I" in dreamless sleep? Is there anything that remains the same in the constant flux of human experience? Is there any continuity, some level of reality higher than waking, in which these states of mind cohere?

These are the kinds of questions the sages asked, but they did not stop with debating them. They became absorbed in the discovery that *as the concentration deepens, the mind actually passes through the states of consciousness being inquired about*. And in concentrating on consciousness itself - "Who is the knower" - they found they could separate strata of the mind and observe its workings as objectively as a botanist observes a flower.

The significance of this discovery cannot be exaggerated. Since consciousness is the field of all human activities, outward as well as inner (experience, action, imagination, knowledge, love) - *a science of consciousness holds out the promise of central principles that unify all of life*. "By knowing one piece of gold," the Upanishads observed, "All things made of gold are known; they differ only in name and form, while the stuff of which all are made is gold." And they asked: "What is that one by knowing which we can know the nature of everything else?" *They found the answer in consciousness*. The study of consciousness was called *Brahma-vidya*, which means both "the supreme science" and "the science of the Supreme"!

It is important to understand that brahmavidya is not intellectual study. The intellect was given full training in the practice of the Upanishadic sages, but brahmavidya is not psychology or philosophy. It is definitely an empirical, laboratory

science where *one's mind is both the researcher, the means of research and the object of research*, with attention turned inward, through a discipline called *meditation*.

However, meditation in the Upanishadic sense is not reflection or any other kind of discursive thinking. It is *pure concentration*, training the mind to dwell on an interior focus without distractions, until it becomes absorbed in the object of its contemplation. This state in which the outside world is totally obliterated from awareness does not mean unconsciousness: meditation is a state of extremely intense inner wakefulness. Brahmavidya is not concerned with the insights that come from concentrating on a particular part of life; it is concerned with *how concentration yields insight at all*. Observing what happens as concentration deepens, the sages of the Upanishads learned to make a science and an art of insight - something that could be mastered and then taught to others [5].

3.1.2 Upanishadic Cosmogony

Having thus mastered the techniques of concentration and meditation, the ancient yogis have developed their consciousness to the highest transcendental and transpersonal states, gaining direct knowledge of their identity both on macro and micro levels.

On the macrocosmic level in their relation to nature they have experienced the whole spectrum of the outside universe, consisting of several interpenetrating layers called "lokas" [6] (Table 1).

Table 1. *Upanishadic Cosmogony* [1]

BRAHMAN (ABSOLUTE REALITY)

The highest God, in Its unmanifested state and undifferentiated unity, containing all possibilities before the divine creativity. Absolute self-aware intelligence in spaceless and timeless potentiality. Inaccessible to human cognition and comprehension while we are grounded in the lowest three worlds of manifestation.

PRAJNANA-GHANA (CREATIVE CONSCIOUSNESS)

Between the Absolute and the World-Soul is prajnana-ghana, creative consciousness, when the Absolute has moved out of Its primal poise and become knowledge-will. This is a logical succession and not a temporal one, because the World-Soul must be there before there can be the world.

ATMAN (WORLD-SOUL)	**ISHVARA (CREATOR-DESTROYER)**
Brahman manifested as the World-Soul, universal self existing in all beings, inanimate as well as animate, rocks and stones, trees, animals and men, although not realized in the same degree.	The creative aspect of Brahman. In its three functions taken separately Ishvara becomes Brahma (the creator), Vishnu (the sustainer) and Shiva (the destroyer).

[1] Compare also with Table 6.

(Table 1, continued)

PRAKRITI (UNDIFFERENTIATED SUBSTANCE)

The seven worlds (lokas) are made by Ishvara of Prakriti, elementary, undifferentiated substance contained both in the mind and in matter. Prakriti is an effect of Brahman, so that Prakriti cannot exist without Brahman. These two are eternally inseparable. Prakriti has been defined as the effect or power of Brahman, the Reality. In other words, this illusion (*maya*, in Sanskrit) of an objective spatio-temporal universe is projected by the Reality itself. Therefore, it follows that Prakriti and Brahman must be co-existent, and that Prakriti, like Brahman, had no beginning and will have no end.

SEVEN LOKAS (WORLDS):

The lokas, planes, interpenetrate. Each plane has its own matter of an appropriate degree of density, which interpenetrates the matter of the plane next below it. In each world the soul develops a new and higher sense of power. When we pass from one dimension to another we do not move in space, but simply change the focus of our consciousness. We have different vehicles (bodies) within ourselves which correspond to and which can function in different worlds. The worlds occupy the same position in space.

(7) BRAHMALOKA, (6) TAPOLOKA, (5) JANALOKA, (4) MAHARLOKA (SUPRAMENTAL WORLDS)

The original Vedic description of the world contains three regions or three spheres: bhurloka (earth), bhuvarloka (astral world) and svargaloka (heaven or mental world). Having attained the highest states of consciousness, the Upanishadic seers have explored and named additional four higher worlds which can be visited and experienced only by self-realized beings. The four supramental worlds are of very rapid and high frequency vibrations, and as such are beyond the reach of ordinary human beings and of their power of conceiving them.

(3) SVARGALOKA (HEAVEN OR MENTAL WORLD)

The mental plane interpenetrates the astral plane, but also extends further into space. This heaven is a thought world, a realm of intense ideation. Whatever one wishes, one gets it at one by immediate materialization of thoughts. Every man builds up his own heaven according to his own desires and imaginations. A life in heaven is very much the same sort of life we lead on the earth level, only much more intense. This heaven is also not permanent. Once we exhaust the fruits of good karma accumulated in the previous life, we have to come down back to the earth world, to start a new incarnation.

(2) BHUVARLOKA (ASTRAL WORLD)

The astral world interpenetrates the earth plane and extends some distance beyond it. The vibrations of the astral world are more rapid than those of the physical plane. The lowest planes of the seven sub-planes of the astral world are called narakas (hells) or asurya lokas (sunless planes) peopled by departed humans with beastly natures and with no good in their hearts. One of such low planes is occupied by the persons with uncontrolled passions and strong sense-cravings, and thus is often called Preta Loka, plane of hungry ghosts (hungry for sensuous experiences of the earth world).

(1) BHURLOKA (THE EARTH OR "PHYSICAL" WORLD)

The "physical" world where we get knowledge of objects through the five jnana-indriyas or organs of knowledge, i.e. the senses of seeing, hearing, touching, smelling and tasting.

3.1.3 Upanishadic Structure of Individuated Selfhood

On the microcosmic level in their aspect as human beings, the Upanishadic sages have discovered different orders of magnitude of their personality, which in the transpersonal states coincide with the macrocosmic aspect (Table 2).

Table 2. *Upanishadic Structure of Individuated Selfhood* [2]

BRAHMAN

Absolute Being whose essential nature is defined as *sat* (self-being), *chit* (self-consciousness), and *ananda* (self-delight). The super-personal transcendental being anterior to any concrete reality. Our true, absolute Self.

ATMAN

The innermost Self of any living creature or object and divine essence of individuality.

Between the Atman and Brahman there is no duality: it is one and the same Reality, the same God, viewed in its two relations toward the Universe. It is both inside and outside, present here this moment and infinitely far away at some other place, in the heart of atom and in all things.

JIVATMAN

The living individual's higher self, the individual as embodied soul in the universes.

JIVA

The individual as a human being incarnated in the worlds of separateness (the lowest three worlds) expressing a space-time personality. This personality consists of three characteristic elements. *Manas* is the recording faculty which receives impressions gathered by the senses from the outside world. *Buddhi* is the discriminative faculty which classifies these impressions and reacts to them. *Ahamkar* is the ego-sense which claims these impressions for its own and reacts to them - it is what we creates our personality or our egoism. ("To identify consciousness with that which merely reflects consciousness - this is egoism" Patanjali, II.6). If the thought-wave is pleasant the ego-sense feels, "I am happy"; if the thought-wave is unpleasant, "I am unhappy". It follows then that as long as there is this false identification of our body-self with these thought-waves, with our egoism, man can never know his real Self, the Atman.

3.1.4 Upanishadic Structure of Man's Bodies

The ancient seers have left behind a description of man's *several* bodies, the vehicles through which man expresses his consciousness in corresponding strata of reality (Table 3). Such are the coverings or the sheaths that hide our real nature, for

[2] Compare also with Table 7.

our true Self, Atman, God within, is obviously none of these, and it cannot be known as long as we are identified with these bodies. They are only instruments for manifestation of various states of consciousness [7].

Table 3. *Upanishadic Structure of Man's Bodies* [3]

According to the Upanishadic sages, the soul creates the gross material body in accordance with the laws of the earth plane in order to provide a "house" for itself in this "physical" dimension. The gross body thus gives the soul the opportunity to be focused in time and space. But, beside the gross body, there are also several other bodies, listed below. All these bodies have their respective etheric doubles (**Pranamaya**), composed of prana, vital principle, the force which vitalizes and holds together the gross body. It pervades the whole organism and its gross manifestation is breath. As long as this vital principle exists in the organism, life continues. Pranamaya has seven major etheric centres or chakras, the areas through which the human personality experiences itself, and they are also a communicative and a controlling link between his bodies. Among them, the etheric double of the human gross material body has seven major energy centres (Table 4), their relative activity being related to different levels of consciousness.

(1) **Annamaya**, *food-body* or *gross body* named from the fact that it is nourished and maintained by food. This body is used by human beings for their actions and movement in waking consciousness.

(2) **Manomaya**, *subtle body* or *psychic body*, composed of manas - thought-forms and desires and emotions. This body is used in our dreaming state when we act unconsciously in our dreams, meaning we are not masters of our thoughts and desires.

(3¢) **Vijnanamaya**, *mental body*, or *lower noetic body*, providing the faculties of discrimination, will power, and clear vision, untainted by emotions, and utilitarian reasoning. This body is also used in our dreaming state, but now consciously and self-consciously, meaning that we have mastered our thoughts and our desires.

(3²) **Anandamaya** - *body of bliss*, as this body is nearest to the blissful Self; it is known also as the *higher noetic body*. In deep sleep, when the body and the mind stop functioning, there still stands the causal (karmic) body between the finite world and the blissful Self (Atman).

3.1.5 Upanishadic Basic States of Human Consciousness

Most of the principal Upanishads, which can be regarded as a unitary work, contain beautiful expositions of the states of consciousness explored by the sages. They have established that there are three basic states which they called *waking, dreaming*, and *dreamless sleep* (Table 5). Their brilliant discovery is that these are not merely alternate states in which a person slips in and out every day, but that they also represent layers of awareness, concurrent strata lying at different depths in the conscious and unconscious mind.

[3] Compare also with Table 8.

Table 4. *Upanishadic Etheric Energy Centres (Chakras)* [4]

The chakras represent the subtle anatomy of human beings just as the "physical" organs represent the gross anatomy. The seven endocrine glands correspond to the seven chakras. The seven chakras correspond macrocosmically to the seven lokas and related states of consciousness.

(1) Muladhara Chakra, located at the base of the spine, governs our understanding of the "physical" dimension. It externalizes as the adrenal gland, governing the kidneys and the spinal column. It is the chakra that is grounding us in the Earth, and survival-oriented, because through it we express our fight or flight when threatened.

(2) Svadishthana Chakra, situated at the base of the genital organs, is the chakra of creativity, governing sex and reproduction.

(3) Manipura Chakra, is located in the solar plexus. It externalizes as the pancreas, governs the action of the spleen, liver, stomach, gall bladder, and aspects of the nervous system. It is the clearinghouse for emotional sensitiveness and issues of personal power.

(4) Anahata Chakra, is the heart chakra. It externalizes as the thymus gland. This chakra governs the heart, blood and circulatory system, and influences the immune and endocrine systems. It is the seat and home of the soul, or our Higher Self. The center through which we feel and express love, and define our personality.

(5) Vishuddha Chakra, is the throat chakra. It externalizes as the thyroid gland, and governs lungs, vocal cords, bronchial apparatus, and metabolism. The centre of self-expression, communication and judgement.

(6) Ajna Chakra, is located between the eyebrows in the centre of the forehead. Known as the "third eye", it externalizes as the pituitary gland. It governs the lower brain and nervous system, the ears, the nose and the eyes. Commands the various states of concentration realized through meditation, and is associated with various cognitive faculties of the mind.

(7) Sahasrara Chakra is located at the top of the head. It externalizes as the pineal gland and governs the upper brain. Through this chakra one may ultimately reach the integration with God. This occurs when Kundalini, the serpent power, is awakened from its coiled position in the lowest energy center, and energizing chakras one by one reaches the Sahasrara.

In dreaming, the Upanishads observe, we leave one world and enter another. "In that dream world there are no chariots, no animals to draw them, no roads to ride on, but one makes chariots and animals and roads oneself from the impressions of past experience." (Brihadaranyaka Upanishad, IV.10) And then the leap of insight: "*Everyone experiences this, but no one knows the experiencer*." What is the same in both worlds, the observer both of waking experience and of dreams? It cannot be the body, for in dreams the observer detaches itself from the body and physical senses and creates his own experiences - experiences which can be as real, in terms of

[4] Compare also with Table 9.

physiological reactions, as those of waking life. Dream and waking are made of the same stuff, and as far as the nervous system is concerned, both kinds of experience are real. When we wake up from a dream, then we do not pass from unreality to reality; we pass from a higher level of reality to a lower one.

Table 5. *Upanishadic Basic States of Human Consciousness* [5]

"Brahman is all, and the Atman (the Self) is Brahman. This Self has four states of consciousness." (The Mandukya Upanishad, I.2)

WAKING CONSCIOUSNESS - VAISHVANARA

In this state a human being lives with all the senses turned outward, aware only of the external world, finding sensual enjoyment in gross objects and convinced that his consciousness is identical to the physical body. The waking state is the normal condition of the natural man, who without reflection accepts the Universe as he finds it.

DREAMING STATE - TAIJASA

In this state the senses are turned inward, and one enacts the impressions of past deeds and present desires. Dreaming is a distortion of even that limited, conditioned reality, but it is in a way higher, inasmuch as we commune with our impressions of experiences rather with the experiences themselves. The mind is now active, though independently of the sense organs, and is without the consciousness of the gross body.

DREAMLESS SLEEP - PRAJNA

In dreamless sleep we leave the sense of "I" completely behind; but we are unaware that we have done so. We are entirely unaware of the external world and also of the internal world. In dreamless sleep we are not conscious of forms or impressions; consciousness is undifferentiated, and individual is not aware of it. In prajna there is no mind, and there is no separateness.

All these three states are merely forms of the Self and of states experienced before illumination; the Self is closest to its true nature in dreamless sleep.

SUPERCONSCIOUS, TRANSCENDENTAL STATE - TURIYA

The fourth is the superconscious state, called Turiya, neither inward nor outward, beyond the senses and the intellect, in which there is no other than Atman in its own pure state. It is neither outer nor inner consciousness, neither semi-consciousness, nor sleeping consciousness, neither consciousness nor unconsciousness. Nothing can describe it, because it is not a state of consciousness, but consciousness itself, beyond the characterizable three states of waking, dreaming, and dreamless sleep. In the union with it is the supreme proof of its reality. It is the end of evolution and non-duality. It is peace and love.

[5] Compare also with Table 10.

If waking and dreaming experiences are impermanent, should there not be something abiding, something real, to support them? Might not it be possible to wake up into a higher state, a level of reality above this world of constantly changing sensory experiences? The sages found a clue: in dreamless sleep the observing self detaches itself not only from the body but from the mind. It is the deepest, most universal layer of the unconscious. Wake up in this state, the Upanishads say, and you will be who you truly are, free from the conditioning of the body and mind in a world unbounded by the limitations of time, space and causality.

Wake up in the very depth of unconsciousness when thought itself has ceased? The language makes no more sense than a map of some other dimension. The sages who have mapped the uncharted territories of consciousness three thousand years ago, must rank with the greatest and the boldest explorers in history. Because the ascent to the summit of consciousness is not for the timid: "Sharp like a razor's edge, the sages say, is the path to Reality, difficult to traverse." (Katha Upanishad, I,3.14). And this is the greatest challenge facing a human being: to climb and reach the highest, the Himalayas of consciousness. It is the same challenge that motivated orthodox scientists like Newton and Einstein to try and penetrate the heart of the Universe. Actually, most of the daring Upanishadic sages came from the warrior caste. They yearned to know life at its core, to know it and master it, and that meant to master every current of the mind. Fusing all their desires into a single most powerful desire for Self-realization, concentrating it like a laser in a single focus on the worlds within, their attention naturally retreated from the sensory channels. As their concentration deepened, there came a moment when the body was no longer felt, when identification with the physical body was dissolved, and the sages knew beyond any shadow of doubt that they were not their body. They also realized that the powers of the brain (being itself a part of the physical body) have no life of their own, *that the brain is not conscious, but only an instrument of the mind and consciousness, because when awareness was withdrawn from the brain, they remained aware*! The Upanishads say that our gross body is the first of many layers that surround the human personality, each less "physical" than the one before.

Going further down (or rather up) in meditation, as awareness was withdrawn from these layers of consciousness one by one, the sages gradually made another astonishing discovery: they realized that they were no more mind than they were the gross body, for when awareness was withdrawn even beyond the mind, there still remained the awareness of "I". Concentration is so profound that the mind-process has come to a standstill. Space and time are transcended. "I" in meditation rests in what the Upanishads call the "body of joy", a silent, ethereal inner realm at the threshold of pure being. All that divides us from the sea of infinite consciousness at this point is a thin envelope of personal identity. That envelope cannot be removed by any amount of will; the "I" cannot erase itself. Yet, abruptly it does vanish. In the climax of meditation the barrier of individuality disappears, dissolving in a sea of pure, undifferentiated consciousness.

This state the Upanishads call *turiya*, "the fourth", for it is beyond waking, dreaming, and dreamless sleep. Turiya is waking up in dreamless sleep: in the very depth of unconsciousness, where one is aware neither of body nor mind. Later this state was named *samadhi*, "complete absorption" and *moksha*, "liberation" or "release", for it brings freedom from all conditioning and limitations of time and space. In samadhi reality is condensed into pure potential, without dimensions, without time, without any differentiation. In this absorption there is no time, no space, no causality. These are forms imposed by the mind, and the mind is still. Nor is there awareness of any object; even the thought of "I" has dissolved. Yet awareness remains: *chit*, pure, undifferentiated consciousness, beyond the division of observer and observed. The whole of reality is there, inner as well as outer: not only matter and energy but all time, space, causality and states of consciousness.

What remains when every trace of individuality is removed? The Upanishad call it *sat*, pure being, for it is in differentiating this unity that created things acquire their name and form. The sages called it *Brahman*, from the root *brih*, "to expand"; Brahman is the irreducible ground of existence, the essence of every thing - of the earth and sun, and all creatures, of gods and human beings, of every power of life.

Simultaneously with this discovery comes another: this unitary awareness is also the ground of one's own being, the core of our personality. This divine ground the Upanishads call simply *Atman*, "the Self"; in the unitive state the Self is *seen* to be one, the same in everyone. In all persons, all creatures, the Self is the innermost essence. And it is identical with Brahman: our real Self is not different from the ultimate Reality called God.

This tremendous equation - *the Atman (Self) is Brahman* - is the central discovery of the Upanishads! Its most famous formulation is one of the *mahavakyas* or "great formulas": *Tat tvam asi*, "You are That".

The joy of this state cannot be described. It is called *ananda*: pure, limitless, unconditional joy. "In the union with the Self one is not aware of what is without and what is within; that is one's real form, where one is free from all desires because all one's desires are fulfilled; for the Self is all our desire."

Nothing less can satisfy the human heart. "There is no joy in the finite; there is joy only in the infinite." That is the message of the Upanishads. The infinite - free, unbounded, full of joy - is our native state. We have fallen from that state and seek in everywhere: every human activity is an attempt to fill this void. But as long as we try to fill it from outside ourselves, we are making demands on life which life cannot fulfill. Finite things can never appease an infinite hunger. Nothing can satisfy us but reunion with our real self, which the Upanishads say is *sat-chit-ananda*: absolute reality (beingness), pure awareness, unconditioned joy.

3.1.6 Upanishadic Controlled Expansion of Consciousness

The methods of attaining the highest state of consciousness are: hearing about, reasoning about and meditating upon the ultimate Reality. One must first hear about it either coming in contact with the sacred books where these techniques are described (Vedas, Upanishads), or from the lips of someone who knows, from a guru, an illumined teacher. But hearing is not enough. No true spiritual teacher demands blind acceptance of his doctrine. In order to reach a firm intellectual conviction, we must reason and reflect about it with an openness of mind and critical judgement. Religion is, in fact, a strictly practical and empirical kind of research. You take nothing on trust. You accept nothing but your own experience. Sound knowledge of natural sciences, logic and philosophical contemplation can be a great aid in this endeavour, and help us to discriminate between the two modes of knowing. Because no teaching which goes contrary to the common sense and to the scientific body of knowledge about the physical world, can be the doctrine of the Buddha, as the Buddhists use to say.

After these two preliminary steps, we are ready for the real thing - the last step on the path of self-realization - *meditation*[6]. The Upanishads say that in its highest form meditation is concentration upon the ultimate Reality, the truth Aham Brahmasmi (I am Brahman), but *to know Brahman one must become Brahman*. However, precise details and full information of the exact method is not formally set down in writing, because in ancient times, as at present and throughout the intervening centuries, the full measure of the teachings was communicated directly from master to disciple. The Upanishads indicate that such details can have no use or meaning for one who is not spiritually prepared, and another reason is that in actual practice they are infinitely varied to suit the needs of individual disciples. The guru has no more important duty than to study carefully the personality and temperament of the pupils committed to his charge, and to prescribe to each, according to his nature, an appropriate method of meditation.

Patanjali's Yoga Sutras (Aphorisms, written down some time about 300 BC) are considered the best and the most authoritative compilation and reformulation of spiritual disciplines and techniques of meditation found in the Katha, Swetaswatara, Taittiriya and Maitrayani Upanishads many centuries earlier. These techniques can be practiced by the followers of any religion, although every major religion contains practices which are basically similar or almost identical to those of Yoga. *Yoga* means *union*, it is a method by which an individual may become united (or rather reunited) with the supreme God, the Reality which underlies this apparent, ephemeral universe. Our own word *religion* in its Latin root has exactly the same meaning - *re* + *ligare* (bind, tie). In its essential meaning yoga is defined as *the*

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[6] "By the yoga of meditation and contemplation the wise saw the power of Brahman, *hidden in his own creation.*" (Svetashvatara Upanishad)

control of thought-waves in the mind. Knowledge or perception is a thought-wave (vritti) in the mind. A thought-wave is raised in the mind whenever an object or an event in the external world is perceived by the senses and registered by the mind. Describing the action of thought-waves, the yogis employ a simple image - the image of a lake. The lake represents the mind and the bottom of the lake the Atman (Reality). If the surface of the lake is disturbed, the water becomes muddy and the bottom cannot be seen. *So, all thought-waves, even the thoughts of the greatest scientists on the "nature" of Reality, expressed through the most sophisticated levels of conceptualization and mathematical abstraction, are still disturbances in the mind, and as such are making the clear waters of the lake muddy and obstructing our view of Reality (the bottom of the lake)*.

This truth is said with proverbial conciseness in the opening aphorisms of Patanjali's Yoga Sutras [1]:

I.2 Yoga is the control of thought-waves in the mind.
I.3 Then man abides in his real nature.
I.4 At other times, when he is not in the state of yoga, man remains identified with the thought-waves in the mind.

Equally clearly it is described in the Katha Upanishad, II, vi.9-11:

"None beholds him with the eyes, for he is without visible form. Yet in the heart he is revealed, through self-control and meditation. Those who know him become immortal. When all the senses are stilled, when the mind is at rest, when the intellect wavers not - then is known, say the wise, the highest state. The calm of the senses and the mind has been defined as *yoga*. He who attains it is freed from delusion."

The perfect knowledge of the Atman (our real Self) is gained in seven stages, starting from the realization that the source of all mystical knowledge is inside us, and finishing in samadhi, reunification and final absorption with Atman. In order to achieve this, we have to practice the eight so-called "limbs" of yoga, to remove the impurities from the mind. For the knowledge itself does not have to be sought. *It is already within us*, unlike that mundane knowledge which must be acquired from books and experiences in the external world.

These eight limbs of yoga are:

(1) *Yamas* - various abstentions from evil-doing (from harming others, from falsehood, from theft, from incontinence, and from greed).
(2) *Niyamas* - various observances (purity physical and mental, contentment with one's place in life, self-discipline, study and devotion to God).
(3) *Asanas* - yogic postures to be followed each day until certain of the higher states of consciousness are reached. Their purpose is to calm the mind.
(4) *Pranayama* - control of the breath and prana (vital energy), which is enabling us to act, move, and think. This is actually the point of contact between the

mind and the physical body, through the centers of energy and consciousness called chakras, which are seven in number (cf. Table 5).

(5) *Pratyahara* - withdrawal of the mind from sense-objects and, through the practice of non-attachment, control of the restlessness of the mind.

(6) *Dharana* - concentration, "turning the mind inwards within a centre of spiritual consciousness in the body" (III.1) or by fixing the mind upon the Inner Light (lotus of the heart)".

(7) *Dhyana* - meditation "is an unbroken flow of thought toward the object of concentration" (III.2); it is prolonged concentration.

(8) *Samadhi* - absorption in the Atman "when in meditation, the true nature of the object shines forth, not distorted by the mind of the perceiver" (III.3).

The first five limbs are only a form of training for the aspirant, to prepare him for the final three, which taken together, are called *samyama*. The practice of samyama leads first to the *lower samadhi*, named *nirvicara samadhi*, in which all the minor thought-waves have been swept up by one great wave of concentration upon a single object - the Atman. The mind becomes "pure" and "filled with truth" because it now experiences direct supersensory knowledge. But this lower state still contains a vestige of the sense of duality, it is still "I" who am meditating on the highest Reality, so there is a separation between the Reality and ourselves.

Now, even this one wave of thought has to be stilled. When it has subsided, we enter the *highest samadhi* of all, called *nirvikalpa samadhi*, which is pure, undifferentiated consciousness; one is no longer oneself, but literally one with Brahman, entering into the real nature of our Self and of the phenomenal Universe and all its forms and creatures. For behind Atman, Christ, behind any idea of a personal God, there is Brahman, the Ground, the central Reality of which these figures are only partial, individual projections. When we are united with Brahman, we are united with That which was manifested in Atman and Christ and hidden within our unregenerate selves, but which is eternally present in all of us.

When it is said that Brahman alone is real, it does not mean that everything else is illusion, but rather that Brahman alone is fundamental. The several aspects of God, the divine incarnations, have their own relative order of Reality. The materialists - those who describe themselves as being "down to earth" - are the ones who *are living in an unreal world*, because they limit themselves to the level of gross sense perception. The perception of the enlightened mystics ranges over the whole scale and covers the whole spectrum of consciousness, from the gross material to subtle, and from subtle to absolute, and it is only the mystic who knows what the nature of this Universe actually is.

How can we be sure that the revelations obtained through samadhi are genuine revelations and not some form of self-delusion or auto-hypnosis? Common sense suggests several tests. For instance, it is obvious that the knowledge so obtained must agree with the knowledge which has already been obtained in the same way by others.

There are many knowers but there is only one truth, as said in the Vedic hymns. Again, it is clear that this knowledge must be something which is not knowable by other means - not knowable by means of our ordinary sense experience. And finally, *when related to the phenomenal world, mystically obtained knowledge must not contradict the knowledge arrived at by the scientists through the conventional scientific methods.*

3.2 Western Legacy - Christianity

> "*The identical thing that we now call Christian religion existed among the ancients, and has not been lacking from the beginning of the human race, leading up to the coming of Christ in the flesh, from which moment on the true religion, which had already existed, began to be called Christian.*" (St. Augustine)

Unlike the Upanishads, the oldest of which were written down about 2800 years ago, which are expounded in almost a modern scientific, direct and precise way of thinking and writing, the sacred books of Christianity - the Old and the New Testament - are mostly expressed symbolically and in parables. ("To you has been given the secret of the kingdom of God, but for those outside everything is in parables" Mark, 4:11, and "He never spoke to them except in parables; but privately to his disciples he explained everything", Mark, 4:34). Also, in contrast to the decentralization of authority and lack of any institutionalization of mystical research in Hinduism, Christianity has been made into a worldly, social institution, claiming the monopoly of the Truth, infallibility of the Pope and authority of the priests, and thus has become a pseudo-religion, discouraging personal experience of the Christ and God, and fostering superstitious belief, labelling heretics and excommunicating anyone within its fold whose opinions are not in accord with its dogmas. In the essence of Christianity there are no barriers to knowledge even though the priests have imposed limits and restrictions. Thus, the practice of the institutionalized Christianity in all of its varieties, is quite the contrary to the methodological injunction clearly stated in the New Testament: "Know the Truth and the Truth will set you free" (from ignorance, from illusions, from egoism...) (John, 8.32). But not the knowledge of Truth of others. *Our knowledge*. Having the teachings of others as guiding torches *we have to work to know the Truth ourselves*. The emphasis is on *us*, it does not mean "others know the Truth, and we accept it blindly". Nobody should believe in anything because it is written in some book no matter how sacred or because it is said by this or that religious authority or mystical master, unless one investigates it himself through reasoning, inquiry and concentration. The knowledge of others should guide us, not convince us, to come ourselves to the conviction. Nobody can demand from us that we believe something without knowing it from our own experience. We can only accept it as a subject for research and the belief will follow, if it does follow, as the product and outcome of that research. *Truths which have not been verified through our personal experience easily degenerate into dogmatism*.

3.2.1 Daskalos' Esoteric Christianity

Esoteric Christianity is not the privilege of the few, but a faithful reflection of the Soul in each of us. The etymological meaning of the term "esoteriko" in Greek indicates *knowledge found within us*, "for nothing is secret that shall not be manifest" (Luke, 8:17). Inner Christianity, as "the secrets of the heart made manifest" (1 Cor. 14:25) is less a religion and more the very nature of life - a clear, concise and complete reflection of the Truth [8].

In spite of the fact that the New Testament has been edited and expurgated, and that many things have been omitted by the early church authorities at various councils, it still contains the Truth and the whole Truth. And the Truth as presented there is for all states of consciousness and can be understood according to the relative level of personal evolution and refinement of consciousness of any particular individual. There is in the Christianity one level of understanding and feeling, and there is the Christianity of another level of understanding and feeling, beginning from a very low outward ritual or hypocritical level, which passes into the persecution of all heterodox thinking, up to the highest level of Jesus himself. Thus there are different distortions of the truth, and in this way the truth is gradually brought down to the level of Church Christianity, though in a completely unrecognizable form. But starting from the Church form, some people who are "pure in heart" may by way of feeling come to a right understanding of the original truth.

In addition to the Old and New Testaments, and various reference books, the main ideas expounded in this paper on the subject of esoteric Christianity have been developed based on the teachings [8-10] of a great contemporary Christian Cypriot mystic, named simply "Daskalos" (Teacher in Greek), who has conducted circles for research of Truth for nearly 60 years in Strovolos, Cyprus, a venerable ambassador of higher states of consciousness from the Kingdom of the Heavens. In their research for Truth, the circles aim at approaching Reality through direct experience; nothing is accepted on blind faith, advocated by most priests as a virtue. Through regular practice of exercises and meditation (encompassing many lifetimes), Daskalos has raised his present personality's consciousness to very high levels of superconscious self-awareness, and mastered all of his three bodies - gross material, psychic (body of emotions and desires) and noetic (body of thoughts).

As a result of these practices Daskalos has developed amazing psychic powers, which are used solely for healing purposes. One of these powers is his ability to remember all of his previous incarnations, some important, some unimportant, since his first descent into the worlds of existence several thousands of years ago. In his many lives he was a hierophant in the ancient Egypt, a Tibetan lama, a Hindu yogi, Aztec shaman, the early Christian mystic Origen, a Russian writer, etc., and although at the very doorstep of Theosis (at-one-ment with Absolute Beingness), he refuses to enter it finally, choosing instead to keep coming back to the gross material world to

serve and help mankind refine its consciousness in this theanthropic activity of God in Christ and of man in Christ through which we realize our Theosis. His desire for repeated reincarnations is making him "too big for a man, but too small for a God".

Daskalos' teachings come from two sources: from his own experiences in the realities in which he moves self-consciously and from entering into a state of complete attunement and at-one-ment with the superconsciousness of Yohannan, the archangelic entity who once lived on planet Earth as Saint John, author of the fourth Gospel. This super-intelligence is the planetary Logos, supervising the evolution of consciousness on the Earth and directly guiding the teachings, using Daskalos as a channel.

The main proof of his teachings is in his extraordinary healing abilities, especially those related to elongation of bones in a shorter leg, realignment of a crooked spine, de-immobilization of paralyzed hands and arms, removal of malignant tumors, and similar feats involving flesh and bone tissue, which rules out any possibility of the patients' or onlookers' auto-suggestion.

3.2.2 Daskalos' Esotheric Christian Cosmogony

Daskalos' cosmogony is divided in two units - the unmanifest state of be-ness and beingness and the worlds of manifestation and existence (Table 6).

A. Absolute Infinite Reality: the State of Be-ness and Beingness

Although our concept of the highest Reality, God, is inevitably limited by the capacity of our human understanding while living in the gross material world, and having in mind that unfathomable Reality is inconceivable and beyond any notions and attributes, we can use the name that God Itself gave in answer to Moses' question in Exodus, 3:14 - "Ego eimi o On" - "I am Beingness" or as generally translated into English "*I am that I am*". It is the same Ego, the same I am, the Self and I-ness expressed by human beings in various limited ways in their manifestation in the worlds of existence.

Absolute Be-ness is a state of Self-aware Absolute Superconsciousness, of Absolute Selfhood, where these attributes of consciousness and self-consciousness mean that it is not a blind, unconscious force, and that It knows what It is. The first characteristic of Absolute Infinite Be-ness within Its absolutely stable state is *Will*; this state is stable because at this point It has not expressed vibration. However, vibration exists within Absolute Be-ness as a state not yet made manifest, vibration without anything moving yet. When the vibration is expressed the Worlds of Existence are planned and Absolute Be-ness becomes *Absolute Beingness* in two modes of expression, as Absolute Selfhood, Christos Logos, and Absolute Superconsciousness, Holy Spirit. The worlds are the common creation of the Christ Logos and the Holy Spirit.

Between beingness and existence, between divine self-sufficiency and divine munificence, there is a new state which is Mind, divine supersubstance out of which all things are made. Everything is Mind - the infinite ocean of various frequencies of vibrations in which every thing is formed and lives, but it does not include Absolute Beingness.

B. Worlds of Existence

According to Daskalos the Worlds of Existence consist of seven heavens or universes (Table 6). The higher four worlds, which individual human beings can enter only after they have attained the state of self-realization, are named the *Worlds of Oneness* (Unity), because in them individuals no longer feel separate from the Creation and other human beings. The lower three worlds are called the *Worlds of Separateness* because human beings have an illusion that they are separate from one another and from everything else.

a) Worlds of Oneness (Unity)

"*And God said, Let there be light: and there was light*." (Genesis, 1:3)

In reality nothing became. Everything is! With the "said", light was expressed from the *State of Beingness* into the *Worlds of Existence*. This is an example of something that is expressed and not created; of something that was already in the world of beingness. Nothing is created for the first time. Everything is!

This is the point where it is possible to answer the eternal question: "Does God exist?". The answer is a definite "No!". *God does not exist - God is*!

These higher heavens we can study not as earthly human beings, but after self-realization, as purified Souls and perfected Spirits, and not through acquiring common knowledge found in books, use of logic and intellect, but through attunement.

b) Worlds of Separateness

The Absolute Beingness is found, in full power and glory, in the infinitely small atoms of matter and in the vast and boundless galaxies; in the depths of the sea and on the snow-capped mountains. It is everywhere, in full and eternal authority, from the utmost depths of the Void to the throne of Its ineffable glory.

The Worlds of Separateness are the poorest kinds even though they give us the greatest paradises and the greatest hells. The Worlds of Separateness include not only the gross material world, but also the psychic and the noetic worlds. These are worlds of forms, images, impressions. They are called the Worlds of Separateness because one sees oneself as a separate entity which gets impressions and interprets

them. It is something other than the real self. In the Worlds of Oneness, the supranoetic worlds, the worlds of ideas, laws, causes, and principles, that are beyond concrete thought forms, separateness is transcended.

Beyond the three Worlds of Separateness - the gross material, the psychic, and the noetic - there is the kingdom of heaven which is within us.

Table 6. *Daskalos' Esoteric Christian Cosmogony* [7]

A. THE STATE OF BEINGNESS:

ABSOLUTE INFINITE BE-NESS (ABSOLUTE INFINITE REALITY)

That aspect of Absolute lying beyond the reach of human and archangelic comprehension. The Ultimate Source, fathomless, and inarticulate depths of the Divine, beyond expression ("... for no man hath seen God at any time" 1 John, 4:12).

ABSOLUTE INFINITE BEINGNESS (GOD THE FATHER)

What we can know of God we see in reflection as witnessed both externally and internally. Absolute Beingness is above all the Divine Common Selfhood, consisting of Absolute Beings within the One Being. Absolute Beingness manifests Itself as the Logos and the Holy Spirit, "and these three are one" (1 John, 5:7). These Absolute Beings are Holy Monads, eternal entities, Logoic and Holyspiritual Archangelic Orders, whose self-consciousness gives this One Reality an appearance of multiplicity.

WILL-PLEASURE (EUARESKEIA)

Absolute Beingness expressing Itself in Itself as Creation. The Will-Pleasure, in Greek euareskeia, carries a sense of pleasure derived from bountiful giving, as practiced by a warmly generous and wealthy source. God's pleasure in creativeness.

CHRIST LOGOS

The Logos, the Divine Common Selfhood, is Absolute Beingness manifested as Self-super-consciousness.

HOLY SPIRIT

Impersonal Superconsciousness that expresses the Omnipotence of Absolute Beingness and makes possible the creation and preservation of the Universes. The dynamic aspect of Absolute Beingness as Omniscience and Omnipotence (closest to the concept of Nature used by scientists).

MIND

Mind is bearer of all life. Everything that exists is made of Mind at varying frequencies of vibration, from super-substance to solid matter. Mind is an emanation of Absolute Beingness imbued with the Total Wisdom, Love, Power and Purity of its Creator. Mind is not an immortal Being, but substance eternally used in all Creation. Mind is divine at its source, and holy in its expression.

The purpose of Mind is the creation of the universes. Although it is only a medium, it also has some form of consciousness, which is expressed as the laws of the material plane.

[7] Compare also with Table 1.

(Table 6, continued)

B. WORLDS OF EXISTENCE:
a) WORLDS OF ONENESS:
SEVENTH, SIXTH AND FIFTH HEAVENS: CAUSAL WORLDS A Above the noetic worlds, less tangible heavens called the causal worlds give definition and order to grosser material universes. The non-dual conditions of pure Love, Causes, Principles, Laws, and Ideas of Creation, cared for by the highest echelons of the Archangelic Orders, exist here in their archetypal state. These heavens can be investigated only by higher aspects of human consciousness. The causal planes give rise to the higher noetic planes. **FOURTH HEAVEN: HIGHER NOETIC WORLD** Higher mental world. Here there are discernible forms in juxtaposition to one another, as yet unexpressed, in perfect harmony and order. A state of ideas in the Eternal Now. From the noetic world the Archangels derive the forms for creating and sustaining the phenomena of life. This is the state where we may come to rest in between incarnations.
b) WORLDS OF SEPARATENESS:
THIRD HEAVEN: LOWER NOETIC WORLD Lower mental world. The most rarefied of the three Worlds of Separation. In the noetical world - the world of thought and home of the noetic body - Total Wisdom of Absolute Beingness first finds expression as thought-forms, ranging from galaxies to unicellular organisms. This is a world of seven planes, each with seven sub-planes. **SECOND HEAVEN: PSYCHIC WORLD** The world of emotions. This super-sensuous world is also composed of seven planes, each having seven sub-planes. The lowest three of these seven planes are the so-called "hells", the fourth corresponds to the idea of "purgatory", and the highest three are the so-called "paradises". When we leave our gross material body, undergoing the sudden change we call "death", we first go to one of these planes using there our psychic body. **FIRST HEAVEN: GROSS MATERIAL WORLD** The lowest vibration of Mind. Mind made solid to compose the three-dimensional gross material world and body. Earth's gross material body is the planetary sphere.

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3.2.3 Structure of Selfhood after Daskalos

Prior to passing through the Human Idea, humanity is an Archangel within the Archangelic Orders. Before their expression, human beings and archangels, as Holy Monads, differ little from each other. Later, however, when they return to be within the

Absolute Beingness, the difference is great. Archangels cannot obtain self-super-consciousness in any of their expressions. This is because they have their being within the Eternal Now and are exposed to various experiences without being able to make comparisons. An archangel of fire, for example, uses this element with Total Wisdom, but does not know the emotions and thoughts which are aroused by the presence of this element. Conversely, human beings, as prodigal children (Luke, 15:11-32) are fully exposed to the worlds of duality, of space-place-time impressions, and are therefore able to develop a keen sense of *individuated self-consciousness*.

After passing through the Idea of Archangelic Man, a ray of the Spirit then continues through the Idea of Heavenly Man to be shaped according to the law of the Human Idea. From that moment it takes on its own separate radiance within Absolute Beingness. A small ray of our Spirit-Ego-Being enters into a separate domain of Total Wisdom, Total Power and Total Love as a Self-Aware Soul. Now we have two foundations for the Inner Self: the Holy Monadic Self within Absolute Beingness and Its emanation which passes through the Heavenly Man Idea to be formed into Self-Aware Soul. Here our Holy Monadic self takes on a separate existence from that of the archangels.

Individuated Selfhood

Corresponding to the seven universes of Creation are the veils which dress the Spirit-Soul-Ego during its sojourn. Human form does not contain the kingdom of the heavens, but rather is the kingdom of the heavens. In other words, the traveller is the journey, the seeker is the sought. And when we seek this kingdom "all things shall be added unto you" (Luke, 12:31).

Human beings in their highest states express the Divine Love, Causes, Principles, and Laws of Creation. In lower, more dense states, as bodies, they express thought (noetic) and emotion (psychic) in the worlds of separateness. Our gross material body, such a small portion of the Selfhood, and yet often mistaken for the self, belongs to the gross material plane.

After passing-over from the gross material plane, we shall continue to live in the psychic world and, later on, in the noetic world, before reincarnating on the gross material plane. The parable of the Prodigal Son (Luke, 15:11-32) shows our free will and decision to leave home, Beingness, and enter into the Worlds of Existence.

The central task of each Soul is to reunify the Self - after its evolution through the cycles of incarnations - into the unified Self in Theosis.

The Individuated Selfhood, as a single unit, encompasses four discernible expressions presented in Table 7.

Table 7. *Daskalos' Esoteric Christian Structure of Individuated Selfhood* [8]

The Individuated Selfhood, in all of its various manifestations, is in the image and likeness [9] of Absolute Beingness (Genesis, 1:26). (In the Hebrew original *Elohim*, which means 'many gods", said "*Na'aseh Adam betzalmenu*" - "Let us make a man in our image, after our likeness".

HOLY MONAD, SPIRIT-EGO-BEING

This is our real Self, in at-one-ment with the multiplicity and self-sufficiency of Absolute Beingness. The Spirit-Ego-Being projects a ray of Itself into Creation. The Will/Pleasure of Absolute Beingness to express Itself in Itself, is identical to the Will/Pleasure of the Spirit-Ego-Being to express Itself in Itself. The Spirit-Ego-Being is not really an expression of the Selfhood, rather it is a creator of the Selfhood.

SOUL-EGO-BEING, SELF-AWARE SOUL

We become a Soul-Ego-Being or Self-Aware Soul the moment a ray of the Spirit-Ego-Being passes through the Human Idea, at which point our Self is understood as something complete, yet seemingly separate from the whole. The Self-Aware Soul with its projections is both Beingness and Existence.

Self-Aware Soul, which is formed of Spirit, then begins to express Itself. As the Soul is of incorruptible Spirit, it is self-sufficient and omniscient. All Souls are equally luminous. The Soul can never be harmed or weakened in any way, so "Fear not them that kill the body, but are not able to kill the soul" (Matt., 10:28). It is the Soul which distinguishes humans from other Beings, for archangels have no need of a Soul as they each belong to a communal order. It is the Soul that harbours the divine individuation of each human Spirit-Soul-Ego when we return to Absolute Beingness. The Soul is the womb of self superconsciousness.

PERMANENT PERSONALITY

Our higher or inner self. Described as "the feet of the soul", this self is an expression of, and in union with, the Self-Aware Soul in the worlds of time and place. The Permanent Personality contains the Divine Laws, Total Wisdom, Total Power and Total Love. The task of the Permanent Personality is to select and supervise the lives and experiences of the present-day personalities through its various incarnations. That part of ourselves upon which the incarnational experiences are recorded and are transferred from one life to next.

PRESENT-DAY (TEMPORARY) PERSONALITY

This is the personality we express in each individual incarnation. It is the projection of the Permanent Personality into the Worlds of Separation and their subplanes. It is that aspect of the Self which experiences emotions, desires, and thoughts, of which a character is formed. With time, this personality learns to interpret the impressions and correct its reactions, so that a refined personality develops. It is this expression of the Selfhood that Jesus asked us to "deny" (Matt., 16:24) so that we may better understand our Real Self.

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[8] Compare also with Table 2.

[9] a) We have *self-sufficiency*. As Absolute Beingness is without any needs, we contain within us everything: "The Kingdom of Heavens is within you." We lack nothing and need nothing that we do not already possess.
b) As Holy Monads, we can express ourselves *self-consciously* within our own universe and within our own selfhood. In a similar way, the Logos expresses Its Self within Its universes as the Common Selfhood.
c) We have the power of shaping the Mind substance into thought and emotion, and of expressing ourselves as love. And when deemed worthy we are awarded the gift of *emanating*, not merely *shaping*, the Mind super-substance, the bearer of life.
d) We have been blessed with the gift and the *responsibility of procreation* for other incarnated Souls. In this way we are co-creators within the Divine Plan, with the Holy Spirit, the Holy Archangels, and the Christ Logos.

3.2.4 Structure of Man's Bodies after Daskalos

Every human being lives simultaneously in three planes of existence (gross material, psychic and noetic) and has a corresponding body for each of these three worlds (Table 8). These three bodies have their respective etheric doubles.

There is a number of psycho-noetic centers located in the etheric doubles of our respective bodies, centers of energy or centers of consciousness, called *chakras* in the East (Table 9), corresponding to many special gifts with which human beings are endowed.[10]

3.2.5 Structure of Consciousness after Daskalos

The simplest definition of consciousness is interactional: it is the capacity of a system to respond to stimuli. By applying different stimuli, we shall elicit different responses from this system. Other definitions of consciousness are transactional - exchange of energy or exchange of information between the system and the environment.

These definitions prove that everything that exists has some level of consciousness, whether inorganic or organic in origin, from the particles within an atom, to galaxies. In other words, *all matter contains consciousness, to a greater or lesser extent.* Consciousness is the main characteristic of matter. Everything on the material plane is conscious.

The lowest type of consciousness is *mineral consciousness*, expressing a kind of *sensitivity*. If we stimulate an atom by applying ultraviolet light or other electromagnetic radiation, one or more electrons may get excited and respond by jumping into a higher orbit farther away from the nucleus. This type of consciousness is possessed by rocks, stones, crystals; that means that they are

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[10] a) Our greatest gift is the *heart*. Through it we may reflect divine love towards God and our fellow men. The heart is the house of the Common Selfhood, the home of the Logos, and we must keep it pure, for "*Blessed are the pure in heart: for they shall see God" (Matt. 5:8)*.
b) Another gift is the *brain* with its psychic and noetic counterparts. This is the centre of inspiration and reason, permitting us to comprehend the presence of God all around us. When Moses began to look within himself and moved up to the level of the cerebellum, symbolized as a burning bush which is never consumed, he heard for the first time the voice of God (Exod. 3:2). The two tablets of Moses on which were inscribed the Laws of God, the Ten Commandments, represent the two lobes of the human brain (Exod. 34:28). When, at some time in our conscious development, we vitalize this etheric centre, we shall also hear the voice of our Inner Self, our Self-Aware Soul, and become one with God's Laws.
c) It is through the solar plexus, another valued gift, that the Holy Spirit expresses itself as will-power and instinctive wisdom. As the seat of subconscious awareness, the solar plexus is also the storehouse for etheric vitality.
d) The fourth gift comprises our reproductive organs, which come into use at the right time, in the right circumstances and at the right age. They are Holy Spiritual. They are the means of perpetuating life on the gross material plane, and they should not be abused.

sensitive to the weather, to etheric vibrations, to electricity, to magnetism - each of these elements we call matter, because - matter is Mind solid and has a certain sensitivity.

Table 8. *Structure of Man's Bodies after Daskalos* [11]

During their period of life in the three Worlds of Separateness, human beings live simultaneously with their three bodies: gross, psychic and noetic ones. Although the psychic and noetic bodies are seen as one with the gross material body, they are in fact separate and can exist independently of each other. The three bodies are the garments that the Self-conscious Soul wears to express itself from one incarnatiuon to another. These three bodies have there respective etheric doubles. *Etheric double*, composed of *ether,*[12] *vital principle*, is the mould around which the gross material body is constructed after the matrix of the Heavenly Man. It cannot exist independently of the gross material body. The phenomenon of death occurs when the etheric double is cut off from the gross material body. Dissolution of the etheric double after it is separated from the gross material body takes about forty days; that is why in the Eastern Orthodox practice a candle is lit for forty days for the deceased person. Every etheric double has several major energy centres, (cf. Table 9).

(1) Gross Material Body is our familiar "physical" body which we use for our movement in the earth plane. It is sustained by solid food, liquids, and etheric vitality (prana) supplied by its etheric counterpart or double. It is the lowest expression of our self. The centre of the gross material body is the chakra of the solar plexus.

(2) Psychic Body or *subtle body* or *astral body* is the body of sentiments and emotions. The psychic body is what we ourselves build of "psychic" substance, having as its centre the chakra of the heart. It constitutes our present-day personality. The quality of the present-day self-aware personality is precisely the quality of its thought-forms containing emotions and desires. The psychic body is also a mortal body like the material one and it is eventually separated from its etheric double, causing our "second death".

(3¢) Lower Noetic Body or *lower mental body*, the body of our thoughts which has the form and shape of our material body. The centre of the noetic body is the chakra of the head.

(3²) Higher Noetic Body or *higher mental body*, is shapeless, existing within the higher noetic world. The higher noetic body concerns laws and causes. The higher noetic body is the set of those vibrations that maintain the cohesion of forms and images at the lower levels. It is the abstract, which is the real. When we exist only with our higher noetic body, we are closer to reality than when we exist with the other bodies. [13]

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[11] Compare also with Table 3.

[12] The *ether* which is necessary for life has four basic properties or functions: creative, kinetic, sensate, and imprinting. In healing and psychotherapy, advanced mystics can draw energy from the etheric double of the psychic body, use portions of all the four kinds of ether and consciously project an *elemental*, and then follow its course and activity. Imprinting ether keeps them informed what that elemental is doing and whether it is doing what it was sent to do. Sensate ether helps them to feel what is going on in the body of the sick person. Kinetic ether is the means for the transport of the elemental, while the creative ether carries out the actual therapy.

[13] We are we whether we have bodies or the form, or not. Because by reaching these high levels of self-consciousness, our Self in not in need of a certain form. We have awakened (resurrected) then to our *divine* nature as God and we can get any form we like and know anything we like, by using

The next in order is *vegetable consciousness*, which in addition to sensitivity expresses also *sensibility*, with a broader range of reactions to stimuli. Plants have a higher grade of sensitivity than the sensitivity of the rocks or the crystals. There is a nice flower. Outside the sun rises and the flower turns to the sun.

Then there is *animal consciousness*, which is manifested through *instinct* and *instinctive subconsciousness*, including in itself also the sensitivity and sensibility. This subconsciousness is common to all kinds of life forms around us and all those modes of consciousness are in the Holy Spirit.

Human beings also have the *holyspiritual consciousness* of minerals, plants and animals, expressed as sensitivity, instinctive consciousness and subconsciousness. There is nothing in the universe that is not in a human being. We do not remain on the instinctive level, although majority of human beings express *subconsciousness* and *waking consciousness* (cf. Table 10).

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attunement and at-one-ment. This is *Superconsciousness*, holyspiritual superconsciousness. When we join it together with the Self, with our *logoic* part, we have *Self-Superconsciousness*.

But no matter which degree of consciousness we express, our Self is always the same, never changing, what is changing is our expression, our level of consciousness. So, we are not our consciousness, it is only the means by which our Selfhood expresses itself. Thus we can express ourselves instinctively, subconsciously, consciously, self-consciously, self-superconsciously, yet - we are one Self. We are not many Selves expressing ourselves in many places.

[14] At this stage the individual is in a position to have an understanding of what Reality is. When eyesight and clairvoyance are transformed into knowledge and understanding we observe the harmonious movement and the opening of the *disc over the head*. And when the mystic advances further he enters into a state of ecstasy, at which point the disc in front of the eyes plays hardly any role. It is the disc on the top of the head that takes over completely. In ecstasy a person becomes one with the Divine, with the higher spheres. The sacred disc over the head moves fast and beautifully, while the movement of the disc in front of the eyes slows down.

This occurs when the *Sacred Fire* (Kundalini) is awakened and through the spine rushes upward. After reaching the centre in the brain it proceeds towards the lotus of the head, absorbing at the same time the surplus energy from the disc in front of the eyes. The extra energy results from the intense concentration that precedes the ecstatic rapture. The state of ecstasy lasts only briefly and only while the present self-conscious personality in coordination and oneness with the permanent personality is focused on the higher spheres.

Table 9. *Etheric Energy Centres (Chakras) after Daskalos* [15]

On the gross material body's etheric double, the etheric centres are called sacred discs or "churches" (Revel. 1:20). In the etheric double of the psychic body, stronger in activity, these centres are called sacred spheres or "lamps" (Revel. 4:5). In the etheric double of the noetic body there are even more active centres with a wider concept of space and time, called "radiant stars" (Revel. 1:16-20). Many Christian saints have opened these sacred discs without ever consciously trying to develop them. They have done it through the practice of virtue, reason, powers of observation and through self-discipline. It is the safest way to awaken them, otherwise premature opening of these centres may be damaging to people's present personalities, causing even some types of mental disorders.

(1) The sacred disc at the lower end of the spine (Muladhara Chakra) is situated at the point of the sacrum. It resembles a red snake with seven coils with its head pointing up the spinal column. Although it looks like a snake, it is really fire. It is the primordial fire within both the gross material body and its etheric double, which constitutes the basis of material existence.[16]

(2) The centre of the solar plexus (Manipura Chakra) begins to move normally while the fetus grows in the womb, because the embryo gets fed through the umbilical cord which later becomes the navel. It is right at that spot that the disc of the solar plexus is perceived. It is *the centre of a brutish type of consciousness*, which has no connection with our self-aware Self.

(3) The disc at the heart (Anahata Chakra) begins to revolve simultaneously with the movement of the disc at the solar plexus. It begins revolving while the infant is still in the womb. The two discs, that of the solar plexus and of the heart, are responsible for offering us the phenomenon of life. After birth the sacred disc at the heart is also responsible for energizing the movement of the lungs. It is the most sacred of all the discs and constitutes *the centre of self-consciousness*. It is the cradle of the Christ Logos.

(4) The disc in front of the eyes (Ajna Chakra) is like a mirror. For an ordinary person this mirror is covered with etheric mist that will not allow the proper reflection of images. This is how life begins for ordinary people. For most people this mirror never clears up. They never learn how to focus their attention, how to concentrate. The way to advance the proper functioning of this disc is through the development of the power to concentrate, to hold in one's mind a noetic image and maintain it for a period of time without distraction. Whether a person will make a good use of this centre will depend on how advanced one is as a present self-conscious personality. When the mirror develops and clears up, it will not only reflect images coming from the outside, but it will begin to reflect images that spring from the centre of the disc, from within. It is at this point that space, is transcended and clairvoyance begins. In a state of clairvoyance ordinary sight is temporarily closed off and concentration from within begins. Then the clairvoyant, like a television camera, begins to receive images from places anywhere on the planet or from any condition of the psychic realms.[16]

(5) The centre of the brain (Sahasrara Chakra) includes two of the most important centres of the etheric double which are right next to one another between the two lobes and the cerebellum. *This is the seat of our self-aware superconsciousness*. The sacred disc which is linked to its corresponding centre in the brain lies over the head about half a foot and revolves in a clockwise direction. This is the normal movement of all the discs.

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[15] Compare also with Table 4.

[16] According to the Old Testament it is the sword of the Archangel Michael, the "flaming sword which turned every way" (Genesis, 3:24), with which the first humans were expelled from the Garden of Eden and which keeps the entity in its gross material state. In the initiates, the awakening of the primordial fire within the material body can burn up the entire etheric double of the human being and cause the death of the material body.

Table 10. *Basic States of Human Consciousness after Daskalos*

The highest type of consciousness is human consciousness which encompasses all kinds of consciousness that exist is the universe.

SUBCONSCIOUSNESS

Three quarters of human personality consists of what is called the subconscious or subconscious mind. Our subconscious and our personality are simultaneously located in our three bodies: noetic, psychic and material. Otherwise, the disintegration of the gross material body upon the phenomenon called "death", would cause the dissolution of our personality.

Our subconscious is triadic in nature, consisting of the following three chambres:

(1) One chamber contains all *elementals* [17] which we have ever created ourselves, or revitalized "ready-made" elementals created by other human beings. Elementals are the basic "building-blocks" of which our personality, our character, is composed, colouring all our intentions, our purpose and our meaning of life. Our every thought, emotion or desire creates and projects outward an elemental, a psycho-noetic thought-form charged with energy, which upon projection carries on an existence and life of its own.

(2) The second chambre contains the life-giving *etheric vitality* (prana in Hindu tradition, and qi in Chinese tradition). This is our "daily bread" in the Lord's Prayer. It is obtained from the Sun, through breathing, meditation, solid and liquid food, and rest.

(3) The third and the most valuable chambre is the seat of the *Logos* and the *Holy Spirit*. This chambre of our subconsciousness is *clean*, not contaminated by elementals. It is the source by which Mind as the formless supersubstance is coming down to be used by the Holy Spirit and the Holy Archangels in building the bodies. Happily, the human being is not able to influence it, as long as he is under the slavery of egoism.

WAKING CONSCIOUSNESS

This is humanity's predominant state of consciousness, consisting of a great variety of discrete altered states of consciousness, although most often expressed as a kind of instinctive subconsciousness.

SELF-CONSCIOUSNESS

Certain rare human beings have developed their consciousness to higher levels - to *self-consciousness*, which means becoming aware of one's real Self, which is not the same as one's present-day personality's self. From this point, a man expresses himself *logoically*, as a God, taking his proper position in the creation, by expressing a Selfhood.

SUPERCONSCIOUSNESS AND SELF-SUPERCONSCIOUSNESSS

Spiritually developed humans possess also Superconsciousness and Self-Superconsciousness. The qualities of this kind of Self-Superconsciousness are the power and the skill of attunement and at-one-ment. Attunement is concentrating on something and getting whatever that something is offering us, offering to our consciousness. Through the power of attunement in one single moment we can know many, many things that through other means of observation we cannot have in studying for years and years. This ability means receiving things and knowledge of things in an instant, for which we would need hours and years to take. At-one-ment is the Super Self-conscious state in which one is able to merge oneself in complete unity with any other being or existence, and with Absolute Beingness in Theosis, without ever abandoning one's Self-Conscious Ego.

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[17] There are two types of elementals:

Contrary to human beings, plants and animals do not have a self, they are not logoic in expression. They are the expression of a hidden self behind them, which are the angels and archangels in their creationism - creating them. There is a self behind them, but these forms are not expressing their own self. That is why a human being is god, but not so animals and plants, because all these are crystallized - materialized - thought-forms, elementals, of the Archangels. Using Mind supersubstance, the Archangels, with their creative meditation are composing all those living forms around us, the mineral, the vegetable and the animal kingdom, and they implant life in these forms, but that life is their Life, it's not independent life of the animals or the plants. This is the point, while a human being is expressing his own Life, because - he is god.

The only true consciousness is self-consciousness. When we start using Mind as *reason* and *pure thoughts*, we become able of a higher expression of our Self as *self-consciousness*. By developing the expressions of our Self as consciousness, we can find out what is our real nature.

The Mind we are using as the means to manifest our consciousness is not God. It is the expression, not the nature of God. What can we know about the Mind as human beings? Very, very little, by using it subconsciously, and most of the time stupidly. But we can know that by using Mind in the right way, we can express and develop a kind of self-consciousness in the various ways of its expression. Most people, even advanced mystics, make the mistake to mix up the consciousness with the Self. The Self is a different thing from the consciousness which the Self is expressing. *The consciousness is the expression of the Self through Mind*. What is behind consciousness? The real Self. The real Self is God, while Mind is not. Mind is as a mirror, many kinds of mirrors, which we use to see the Reality reflected in them.

We shall learn the nature of the Mind as emotion, what is Mind as thought, and finally what is Mind itself as formless supersubstance - making it a crystal clear

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a) Emotional thought-forms or desire-thoughts, when negative emotion prevails over thought, motivated by base and selfish desires, such as greed, hatred, anger, malice, envy, jealousy. Desire-thoughts contain maximum amount of emotion and a minimum amount of thought.

b) Reasoned thought-forms or thought-desires, when desires have passed through reason. Thought-desires contain maximum amount of thought and a minimum amount of emotion. Predominance of desire-thoughts elementals degrades our subconscious, and thus our character and our personality. As with material bricks, which we can use to build either a palace or a prison, so desire-thoughts imprison our free-will and we become slaves of our desires and our emotions. Improvement of our subconscious begins when we master our thoughts and put all our desires and emotions under a strict control.

As we need physical hygiene when our material body gets dirty or starts sweating, no matter whether we are blue-collar workers or Nobel-prize physicists, daily hygiene of our subconscious is also most necessary. It is done through regular self-observation, introspection, and an analysis of the quality of our thoughts and desires, leading us to self-knowledge.

mirror to see ourselves reflected in it. Yet, what we see in the mirror is not our Self. It is our image. What is this crystal clear mirror? Our *Self-Superconsciousness* (when we raise our consciousness to those high levels as Self-Superconsciousness). *Yet, we are not the Self-Superconsciousness*. The Superconsciousness is our expression. We, our Self, are behind it. At that moment we have them united - the Self and Superconsciousness. The one expressing itself (the Self) and its expression, or, the manner in which it is expressing itself (the Superconsciousness).

It is a great reward to see our Self reflected as Superconsciousness and compare it with the self we were seeing in the three dirty mirrors (gross material, psychic and noetic bodies). Then, we will rejoice. We will now know what we are looking like. Yet, we must find what we are - not what we are looking like. We should not stay there. We should find our real Self. God. What is the form of this God, of our Spirit-Soul-Ego? Formless - yet, everything. What is its name? There is no name except - "*I am*".

In that state we can become anything, being - ourselves. All forms are ours, are in us, are in the Kingdom of the Heavens which is in our own nature. We can become anything and know anything. Then, we will understand what is God.

By expressing our divine nature as gods, we can develop in us to some extent *omnipotence, omnipresence and omniscience*.

So, no human being has possibilities in using Mind and thought in a way that any other person cannot do. As everybody is entitled by God to breathe and make his material body live, so everybody is allowed and can use the Mind as Super-substance in developing his consciousness from subconsciousness to become an awakening consciousness, self-consciousness, and then superconsciousness. There are no limits. Nobody can say, "What I can do nobody else can do." It is a matter of time and training, and the will to get that knowledge.

The main difference between human beings is in the quantity and quality of their individual consciousness, and not in terms of their physical appearance and social and professional stature, their wealth or their possessions. Modern man is still preoccupied with the struggle for survival and physical *existence* which leaves no time to dedicate himself to the pursuit of his *beingness*. Whenever there is no existential struggle for survival, man turns to non-survival oriented activities of art and religion.

Why are all human beings not on the same level of consciousness? They are not, because *they don't want to*! If they want, they can be. Because the Absolute Beingness and the Logos, as the Lord of Selfhood, is giving us in abundance Mind to use it. Everybody has the right to the daily bread which comes from heaven, which is Mind. But do we use Mind?

All over the world, in highly civilized countries, and in the third worlds countries, among aborigines, human beings are using Mind *subconsciously*. Even those

calling themselves scientists. They don't use Mind self-consciously or consciously. By using Mind subconsciously focused on gross matter, the scientists are presenting humanity with wonderful things: radio, television, spaceships, computers, many, many things. But *there is no life* in those things, because they are not using Mind supersubstance self-consciously, as Archangels are doing: they are using Mind creating *living* things.

3.2.6 Controlled Expansion of Consciousness after Daskalos

Spiritual development is not simply a matter of theoretical knowledge, but requires rigorous, continuous and patient exercise. The steps and techniques are identical in all religious traditions, although the actual details are different to suit the differences in the nervous systems.

(1) Patterned breathing (cf. pranayama in Patanjali's eight limbs of yoga, cf. 3.1.6) - from the moment we are born into the world we breathe. Breathing is basic to life. Along with the food, rest, sleep, and sunshine, breathing is a major source of etheric vitality necessary for the generation and regeneration of a healthy life. Mostly, people breathe instinctively, and their breathing is shallow, not allowing etheric vitality to be distributed all over the body, and resulting in poor health.

Al least twice a day for a period of about five minutes, we should breathe *consciously*, gaining control over the work of our lungs. We should begin by relaxing as much as possible, forgetting all our worries and freeing the mind and body of all activity. One full inhalation through the nostrils is followed by a full exhalation through the mouth. Breaths should be patterned on the counts of the heartbeat, in the beginning 3:3, then 4:4 and 6:6. We first fill our abdomen, then the torso's midsection and lastly the chest. As soon as the chest is full, we immediately begin to release the breath, starting with the abdomen, and finishing with the lungs.

(2) Concentration (cf. dharana in Patanjali) - The first condition for creative thinking and healing. Concentration should be focused as a magnifying glass, which no outer distractions can disturb, to self-forgetfulness of the present-day personality.

(3) Observation (cf. dhyana in Patanjali) - Attention without tension. Perfect concentration. The ability to observe in detail and to recall what we have observed is vital to our understanding of the Reality. Observation is an aspect of our divine nature. Observation and concentration make us both human and gods, as we can probe the outer and inner worlds deftly and gracefully. It is through observation that we are able to expand our conscious awareness to endless heights. In increasing our awareness and understanding of our surroundings, becoming keenly aware of all the nuances, we will move out of the small shells of our personalities and into the larger truths. There are no limits how far we can extend our comprehension of the Reality when we develop our ability to concentrate and observe.

The more aware we become of the world which surrounds us, the more conscious we will be in the worlds beyond. This applies equally to our nightly visits, when we sleep and "dream", to the other planes, as it does when we eventually pass over from the material plane into the more refined worlds. Through enhanced observation comes an ability to see beyond apparent limitations and to control the course of our experiences in the psychic and noetic worlds.

(4) Visualization (cf. dhyana in Patanjali) - The most important skill for performing an exercise is visualization - the ability to form psycho-noetic images and scenes. Psycho-noetic images are elementals constructed of Mind super-substance at varying rates of frequency. Once created, an image has a real, multi-dimensional existence that is far more durable than any gross material object.

After learning to observe carefully and to concentrate fully, we gain the ability to visualize consciously. There is nothing more powerful than thought, and visualization is the process of harnessing thought in a constructive manner. We visualize all the time, mostly unconsciously, by creating elementals of uncontrolled desire-thoughts, and this is the way in which we create our world.

Visualization should not be confused with fantasy. In shaping substance (using creative, kinetic, imprint and sensate ethers) human beings seek to replicate the work of the Logos and the Holy Spirit by faithfully reproducing noetic forms. Visualization is used as a vehicle for expansion of our consciousness, as it is the *language* between the mundane and the divine, and the "key" to the kingdoms (Revel. 3:7). By constructing specific forms and settings we allow for interaction with divine energies. Additionally, visualization is indispensable in healing work for invoking images of health and perfection where illness and disease have set in. Our ability to form these images is a most divine gift and privilege that we need to fully develop.

(5) Introspection (cf. yamas and niyamas in Patanjali) - An inner exploration to trace the sources of our emotional and noetic behaviour with the resolve to self-consciously structure our personality and its subconsciousness. The determination to free ourselves of the limitations of egoism, by releasing "your conscience from dead works" (Hebr. 9:14) is moving towards the wise and loving voice of the Soul.

Daily introspection, "looking within" is the process of self-examination, of "knowing thyself". This is the core practice of every Researcher of Truth, and of all those interested in Self-Realization, whose aim is "the euthanasia of the egoism".

(6) Meditation (cf. samadhi in Patanjali) - In meditation the exploration moves beyond the subjective experience of the present-day personality, into the boundless oceans of the Mind, towards alignment with the universal and eternal and unions with the Absolute superconscious self-awareness.

The systematic practice of meditation within a definite and accepted spiritual framework is congenial to all religious schools of the world, for either goal is the same - to bring the aspirant to the highest state of consciousness. Through these techniques one finally transcends all levels of the mind and goes on to Christ consciousness and realization of the absolute consciousness. Meditation does not require a belief in dogma or in any authority. It is an inward journey in which one studies one's one self on all levels and ultimately reaches the source of consciousness. The aim of meditation is Self-realization - a direct vision of Truth. The meditative experiences that great mystics have witnessed from the deeper realms of their being - experiences that do not come from the contact of the senses with sense objects. "And when he was demanded of the Pharisees, when the kingdom of God should come, he answered them and said, The kingdom of God cometh not with observation. Neither shall they say, Lo, here! or, Lo, there! for, behold, the kingdom of God is within you." (Luke, 17:20-21).

Meditation gives a direct vision of God in the temple of the body.

When Jesus invites us "Come to me, all who labour and are heavy laden, and I will give you rest. Take my yoke upon you, and learn from me; for I am gently and lowly in heart, and you will find rest for your souls. For my yoke is easy, and my burden is light" (Matt. 11:28-30), he is encouraging us to practice the discipline of stillness and meditation. The word that he used, **yoke** in English is from the same Sanskrit root as the word *yoga*, both signifying union or binding together, and are used in appropriate contexts to indicate preliminary disciplines as well as the achieved state of God-realization, or universal Christ-consciousness, which is the goal of all spiritual effort. Thus, Jesus was saying "My *yoga* is easy...".

This Self-realization (the realization of God within) is an ever-present possibility because it is an ever-present reality, though in a latent state of awareness. The power, awakened in the aspirant, to achieve this level of superconscious awareness, is the power of the indwelling Christ (our Common Selfhood) in every person.

The teachings of Jesus conveyed in the Gospels constitute, in essence, a manual for meditation. In figurative language they describe the various stages of meditation, provide guidelines for overcoming obstacles in practice, and explain the ultimate outcome of the meditative endeavour [11].

3.2.7 Daskalos' Meaning of Christianity

> "*For this I came into the world that I should bear witness unto the truth. Every one that is of the truth heareth my voice*." (John, 18:37)

Although we live in the so-called Western or Christian world, we are all aware only of the cultural implications of Absolute Beingness' manifestation on the Earth. Socially, the greatest revolution in our civilization is the transition from paganism to

Christianity. This is reflected most clearly in our calendar, our counting of time, which is referenced to the year when the Logos was incarnated and humanized in the body of Jesus of Nazareth. Our greatest works of art are based on the Christian symbolism, particularly in painting, sacral architecture and in music. However, in spite of Christianity being the dominant form of religious practice in the Western world, the real meaning of this momentous event *in terms of evolution of human consciousness* escapes almost all of us.

Jesus Christ appeared on our planet at *the midway point, between our beastly unconscious past, and the superconscious state of Theosis or God-realization*. Our Holyspiritual expression of a subconscious type of waking consciousness was joined then by the logoic expression of human beings as self-conscious creatures. The latter is inevitable end stage and destiny of every Spirit-Ego-Being that has passed through the Human Idea and embarked on the path of evolution through the cyclical spiral of incarnations.

The Logos expresses Itself within a civilization, within a planet, at the point when human consciousness has reached such a level that makes the manifestation of the Logos possible and meaningful. The expression of the Logos within the universes is within the static condition of the Absolute. The Christ Logos is born and crucified eternally within the static condition in the universal memory of the Absolute. And this static condition expresses itself within time and space according to the level of consciousness reached by entities that passed through the Human Idea.

Whoever had been able to penetrate into this static condition within the Absolute, had been able to foresee the manifestation of Christ at the historical juncture that it took place on our planet about 2000 years ago.

One of such persons was the Buddha who prophesied that within about five hundred years the Logos Itself would descend and incarnate within a human body. Buddha had recognized that the average state of consciousness on our planet had reached such a level that at that point it made possible and inevitable the logoic expression. The Buddha had reached the heights of the third heaven, the point where he was beginning to transcend his human form. The Buddha was not an accidental self-consciousness. After entering that state he was able to foresee what was about to happen and instructed his disciples on the matter. It was his prophesy that alerted the three Magi from the East to travel to Bethlehem in order to pay homage to the newborn Godman.

Buddha foresaw a structural turning point in the evolution of humanity. It is possible for advanced masters to declare with mathematical precision what stages humanity will have to follow in its evolution toward perfection. The stages of the development of humanity are predetermined within the Divine Plan, the blueprint within which events will unfold within time and space. The incarnation of the Christ Logos in the body of Jesus of Nazareth was not just a historical incident within the time and space confines of this planet, but a *structural turning point in the evolution*

of human consciousness on the Earth. It is a stage that is inevitably reached on any planet upon which human evolution unfolds, when God Himself incarnates directly to prove our own divinity. It is part of the static condition within the Absolute, eternally. The incarnation of Absolute Beingness-Logos is offered to humanity at the level of collective spiritual development to help humans realize that their destiny is to become gods themselves [12-14].

Buddha was not the only one who in his higher levels of consciousness entered into the static condition of the Absolute related to the appearance of the Christ in time and history. The rishis, the sages, of the Upanishads, being master technicians of states of consciousness, also penetrated into this static condition, describing the Christ as the Atman, both as the Divine Selfhood, and our own inmost self. Bhagavad Gita, which is also an Upanishad, is a symbolical dialogue between man's present personality self and the divine Self, named Krishna, in which the avatar (divine incarnation) Krishna explains under what circumstances God himself incarnates as a human being.

Another proof we find in the New Testament, where Jesus himself confirms the fact that Abraham was also able to enter into the static condition of the Absolute "Your Father Abraham rejoiced that he was to see my day; he saw it and was glad." (John, 8.56) and "Truly, truly, I say to you, before Abraham was, I am." (John, 8.58). (Here Jesus did not say "I was", but "I am", because he was speaking as the Son of God in the Eternal Now.) In Genesis 24.1 we read "Now Abraham was old, well advanced in years" (more literally translated as "He went into the days") meaning that Abraham was shown into the age to come, including the days of the Messiah.

Exactly the same concept is found in the original term for Hinduist faith as *sanatana dharma*, "the eternal law". It is a statement constantly referred to in the Upanishads, that the Vedas were created eons before mankind. We tend to think of texts as coming at the end of the immense evolutionary process, after humans had evolved, culminating in the faculty of language. Under the term *sanatana dharma* the Hindus do not mean the literal, linguistic form of these sacred documents. They mean that the truths embodied in these forms lie so deep that they constitute *templates of reality* and that they reveal the *plan of evolution*.

Why has Christianity taken root only in the Western civilization, while the East has retained its original forms of religion? Because the essence of Eastern religions expressed the spirit of Christianity long before the appearance of the Christ in the flesh. The concept of the Atman (Self) is the glory of the Upanishads, and as described therein, it is identical with the esoteric concept of the Christ Logos. The fundamental equation in the Upanishads "The Atman is Brahman" finds its exact equivalent in the statement of Jesus, "I and my Father are one".

Christ himself has confirmed the teachings of all great religions and additionally proved them with his own life and deeds. So, Christianity in all of its aspects - practical, psychological, philosophical and ethical, had been part and

parcel of the religious traditions of the East, only under different labels. ("Wherever you encounter truth, look upon it as Christianity", advises Erasmus.)

Christian Symbolism

*Crucifiction***.** The drastic act of the crucifiction of Jesus Christ on the cross is a masterful theatrical and mnemonic device designed to be impressed deeply in our consciousness. But the real meaning of the cross is the human body with arms outstretched in which our present-day personality, our egoism, identifying itself with our body, emotions and thoughts, has crucified a living god.

*Resurrection***.** Resurrection does not mean that on some unspecified judgement day we shall recompose our gross material body, that sack of earth, and continue to live forever thereafter in a paradise. We shall resurrect ourselves when we wake up to our real state and nature, realizing that we are not what we thought we were, a material body, which has to die, but a Spirit-Soul Self, an immortal god.

Salvation from the dead. It is often said that Christ is our Saviour, that he came to save us from the death of the grave. But that grave is not a six feet deep soil in a cemetery, where our material body will be buried one day. The grave is our very material body (made of earth) in which we, as a Spirit-Soul Self, are buried alive! Death, which does not exist in reality, is a belief that the only reality is our present-day personality which will be annihilated with the disintegration of our corruptible body. Salvation is to disentangle our self from the illusions of time and place and from enchantment with matter.

Lord's prayer. Many Christians pray every day using the text recommended by Jesus himself, but without realizing the proper meaning of some key words in the Lord's Prayer:

"Our Father Who art in Heaven, hallowed be Thy Name. Thy kingdom come, Thy Will be done on Earth as it is in Heaven. Give us this day our daily bread and forgive us our transgressions, as we forgive those who are transgressing against us. And lead us not in temptation, but deliver us from evil. For Thine is the kingdom and the power and the glory forever."

The oldest known texts of the Gospels, that is the Greek and the first Latin translations, are much more abstract than the later translations. There is much in the earlier texts that is found in the form of an abstract idea, which in the later translations has become a concrete image, a concrete figure. One of such distortions of the Gospel text is in the well known words from the Lord's Prayer about daily bread - "give us this day our daily bread". This qualification of bread as "daily", "quotidien" (in French), "täglich" (in German) does not exist at all in the Greek, Church-Slavonic and the Latin texts. The Greek text term for the daily bread is "epiousios", and the Latin text reads: "panem nostrum supersubstantialiem da nobis hodie"; in Church-Slavonic the expression used is "nasushniy".

The Greek word epiousios, which is translated by the Latin word supersubstantialis according to the explanation of Origen did not exist in the Greek language and was specially invented for the translation of the corresponding Aramaic term. So, in no way this word meant "necessary" or "daily", because supersubstantialis means "super-existing" or "super-substantial", which is also confirmed by the meaning of the Church Slavonic word.

That its meaning is not bread made of flour, is confirmed by Jesus himself, when he was tested by the tempter, saying: "Man shall not live by bread alone, but by every word that proceeds from the mouth of God." (Matt. 4:4), which is a reference to the Old Testament when Moses reminds Israel that God "fed you with manna, that he might make you know that man does not live by bread alone" (Deut. 8:3).

Thus, it is obvious that this supersubstantialis is not bread which we can buy in any bakery, but *the Mind-supersubstance*, pure thought-forms, (and not the lower quality of Mind-substance with which we feed our base emotions and egoistic desires), and *Mind-vitality*, etheric vitality, prana, of which we all get a certain quantity every day.

Another most interesting transformation of this kind has occurred with the idea of evil.

"...lead us not in temptation, but deliver us from evil". In the Latin translation this phrase reads "sed libera nos ab illo improbo" - from the wicked one; in the Church-Slavonic it is "izbavy nas od lukavago" - deliver us from the sly one, in French "mais délivre nous du Malin" - deliver us from the Evil (Wicked or Sly) one, and in with the same meaning in Italian "ma liberaci dal maligno".

In most contexts in the New Testament this sly or evil one is certainly the visible, deceptive, illusory, phenomenal world, the gross material world of three dimensions, "Maya".

The only way in which we can liberate ourselves from the enchantment of the illusions of matter offered to us through the five senses is through the use of Mind-supersubstance.

4. PSYCHIC PHENOMENA IN ESOTERIC TRADITION

Descriptions of most diverse psychic or paranormal phenomena are found in the canonized texts of every major religion of the world. Actually, the very sacred texts, the central foundation on which respective religious beliefs are based, are of suprahuman origin, revealed to various portions of humanity by higher celestial beings or directly by God Himself. The Christian Bible is no exception; it is a voluminous catalogue of all kinds of miracles and supernatural phenomena, which are treated there in a manner so matter-of-fact, as a part of everyday reality.

Such phenomena in an unbroken tradition still abound in all Eastern religious practices, where yogis, lamas, arhants, and enlightened masters are in full possession of many of psychic powers. On the other hand, Christianity has become a sterile scholastic study in dogmatism, whose priests are mere functionaries ("apparatchiks") in the hierarchies of formal religious structures.

So-called occult or psychic powers are described by Patanjali in Part III of his comprehensive treatise on yoga psychology, Yoga Sutras. While engaged in explanation of samyamas - combined concentration, meditation and samadhi (attunement and at-one-ment), Patanjali refers to the way in which the mind, deeply absorbed in any particular object or thought acquires occult powers and psychic phenomena occur. Different powers are acquired as a result on concentration upon different objects.

Patanjali has listed about forty techniques - samyamas on different objects - which result in various psychic powers, some major, some minor ones. Table 11 presents the eight siddhis that are traditionally considered the major ones [15].

The following samyama is of special relevance for the subject of mystical cognition:

III.53 By making samyama on single moments and on their sequence in time, one gains discriminative knowledge.

III.55 This discriminative knowledge delivers a man from the bondage of ignorance. It comprehends all objects simultaneously, at every moment of their existence and in all their modifications.

Our ordinary knowledge is based on sense-perception in a sequence. We learn one fact about a given object, then another fact, then more and more facts. But the yogi who possesses discriminative knowledge understands objects totally and immediately. If, for example, he meets another human being, he knows him at once in all his past and future modifications, as a baby, a youth, an adult, and an old man. This equally applies to his knowledge of life of a galaxy, from its birth, through billions of years of its existence, to its final dissolution. Such knowledge is infinite; it is within eternity, not time. It delivers a man from the bondage of karma and ignorance.

However, even this exalted state of omniscience and omnipotence should be renounced: *By giving up even these powers, the seed of evil is destroyed and liberation follows*.

The "seed of evil" is ignorance. Because of ignorance, man forgets that he is the Atman and creates for himself the illusion of a private, separate ego-personality. This ego-personality is intent upon satisfying its desires and acquiring possessions and powers over external nature. Of all powers, the psychic powers are, from the standpoint of the egoism, the most desirable; and of all the psychic powers, omnipotence and omniscience are obviously the greatest. The yogi who has held even these powers within his grasp and nevertheless renounced them, has rejected the ultimate temptation of the ego. Henceforth, he is freed from bondage.

Table 11. *Upanishadic Psychic Powers (Siddhis)* [18]

Numerous aspirants are attracted towards the practice of yoga, especially hatha yoga or kundalini yoga, by the thought of the extraordinary psychic powers they are likely to acquire through it. However, these powers are not to be taken for the goal. They are no criterion for measurement of one's level of spirituality, but rather the indicators of the progress the practitioner has reached.

(1) Anima - becoming as tiny as an atom.

(2) Mahima - becoming as large as the universe.

(3) Laghima - becoming as light as air (levitation).

(4) Garima - becoming as heavy as lead.

(5) Prapti - acquiring supernatural powers such as predicting future events, clairvoyance, clairaudience, telepathy, thought-reading, understanding foreign languages, and the languages of the beasts and birds, curing all illnesses, etc.

(6) Prakamya - living under the water, becoming invisible, entering the body of another person, keeping a youth-like appearance for many years, etc.

(7) Vashitvam - the power of taming wild animals, control of passions and emotions, mastery of elements.

(8) Ishatvam - attainment of divine power, restoring life to the dead.

At several points in his exposition Patanjali warns that occult powers are the greatest stumbling blocks in the path to Truth and that they have nothing to do with spiritual life. Likewise, Buddha told his disciples very definitely never to put faith in miracles, but to see truth in eternal principles. Jesus spoke sharply against those who "seek for a sign", and he himself rejected the psychic powers offered to him by Satan in the wilderness. [19]

Scientific interest in the study of psychic phenomena began in 1882 with the foundation of the Society for Psychical Research in London. However, the landmark in academic experimentation is the research initiated at Duke University in the 1930's by J.B.Rhine and L.Rhine. After decades of thoroughgoing investigations of various psychic phenomena (classified in Table 12), the existence of ESP and PK phenomena has been demonstrably proved, but with little comprehension of their nature and inability to provide adequate theoretical models [16,17]. The inconclusiveness of such results is mainly due to the following factors:

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[18] Compare also with Table 12.

[19] Anyway, Western man has made a different choice, preferring to concentrate on the production of mechanical rather than psychological powers. And so, instead of telepathy, we have the telephone, instead of levitation, we have the aircraft and helicopter, and instead of clairvoyance, we have television. However, in the same way as the psychic powers can divert us from the path and cause our spiritual downfall, the technological powers also deify matter and make us more enchanted and more attached to matter, enslaving further our real Self to the illusion of the phenomenal world.

a) The subjects tested got into possession of their psychic powers *spontaneously*, without any intentional spiritual training, and thus could not exhibit them at will,

b) As a consequence, laboratory replicability was pretty poor,

c) Decline effect over time is manifested, when the performance of psychic powers drops down to the statistical average.

Table 12. *A Western Classification of Psychic Phenomena* [20] *(after Jahn)*

(1) Extrasensory Perception (ESP)

Acquisition of information from sources other than through the regular channels of sensory perception.

(A) Telepathy (thought transference between persons)

(B) Clairvoyance (perception of remote physical objects or events)

(C) Precognition/Retrocognition (perception of future events and events in the past not accessible by normal recollection)

(D) Animal ESP (inexplicable capabilities of animals, such as: psi-trailing, homing, collective behaviour, communication)

(2) Psychokinesis (PK)

Influence of human consciousness on physical and biological systems.

(A) Physical Systems (interaction may range from microscopic disturbances of atomic-level processes, through macroscopic distortion or levitation of objects, up to some very drastic poltergeist effects).

(B) Biological systems (psychic healing and man-plant interaction)

(3) Survival

Survival of personality's consciousness upon bodily death.

(A) Reincarnation (repeated cycles of birth, death and rebirth until final self-realization)

(B) Apparitions (ghostly appearances of persons or things)

(C) Mediumship (ability of persons to serve as mediums or channels of communication between living and departed humans)

(4) Out-of-Body Experiences (OBE)

Projection of one's consciousness outside the body, astral projection, autoscopy and bilocation.

[20] Compare also with Table 11.

Therefore, in any future experiments, no matter how sophisticated measuring equipment, or rigorous control protocols or proper statistical methods in the *artificial* environment of a laboratory, end results will invariably prove to be of marginal significance for the conventional science.

The proper role of unsolicited and spontaneous psychic powers is in the anecdotal occurrences in *real life*, where they are manifested only when there is a *special need*, imparting a lesson to the persons concerned relevant for their spiritual understanding and transformation. Great masters, like Daskalos, who are in full control of their psychic powers, never display them to satisfy the mere curiosity of miracle seekers, but use them only for the purposes of serving, healing and helping.

5. WIDER IMPLICATIONS OF YOGIC/MYSTIC DISCIPLINES

The revolutionary theory of our identity, that our real Self is God, verified both in the Upanishads by the ancient Indian sages, and in the New Testament, *proved in the flesh* by the Godman Himself, provides a firm basis for implementation of this realization in our relationship with ourselves, with other people, with various social groups and with other nations.

The central value of Hinduism, expressed in the well-known Upanishadic formula *ahimsa paramo dharma*, "the highest religion, the ultimate law, is nonviolence", is also the central virtue of Christianity: "resist no evil" and "love your neighbour as yourself". First we should practice *ahimsa* with ourselves: if our behaviour is dictated by our addictive habits and our desires, whenever these desires cannot be satisfied for objective reasons, being related to objects outside us, and thus beyond the power of our control, we begin to suffer, doing violence to ourselves.

That the doctrine of ahimsa is very practicable and efficient in all situations of grave social turmoils was proved by Gandhi himself, physically a small man, who freed India from the colonial status by a dedicated application of non-violent resistance by prevailing against the British Empire in the height of its historic majesty.

Our economic thought operates, as social historian Ivan Illich put it, "under a paradigm of scarcity". The fundamental assumption is that there is not enough to go around, so we are doomed to fight one another (and an unwilling nature) for material, human, natural, resources; each person or group for itself. We call this evolution, and think that this is life.

It is not true, says the Isha Upanishad. [21] That is social darwinism, based on the economics of materialism. Spiritual economics begins not from the assumed scarcity of

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[21] "All is full. All that is full.
From fullness, fullness comes.

matter, but from the veritable *infinity of consciousness*. As Gandhi said, "There is enough in the world for everyone's need; but there is not enough for everyone's greed".

The West has been a nominally a New Testament civilization for two thousand years, but we still operate on Old Testament revenge values in many sectors of our lives - not the least of which, ironically, are the relationships between different phases and flavours of our religions.

Internal laws of many countries and international laws governing behaviour between nations still contain many traits of barbarism, which bears within itself the principles of violence and destruction - the principles which cannot exist in civilization. Thus, violence and evil are coded in criminal legislation - having codification of murder (death penalty) in the penal law, directly contravening the commandment "Thou shall not kill".

The savage man killed with a club. Cultured man has at his disposal every sort of technological appliance, nuclear bombs of terrible power, electricity, bomber aeroplanes, submarines, aircraft carriers, poisonous gases, ballistic missiles with war heads - but all these are means and contrivances for mass destruction and extermination, in essence nothing but evolved forms of the club. They differ only in the degree of their power. The culture of the means of destruction and the culture of the means and methods of violence are the culture of barbarism.

With the implementation of the esoteric method it will always be possible to find solutions to problems too difficult or too big for the logical mind. Real solutions can come only from higher mind possessing higher consciousness, that is from esotericism. The esoteric method is limited by nothing and always connects every given thing, however small it may be, with the whole.

The danger of the logical method in all possible spheres in life lies in the fact that at the first glance it is the easiest and the most effective way.

6. CONCLUSION

The message of esoteric teachings from the dim ages of Vedic seers, through the Old and New Testaments, and down through the many centuries to our own day, has consistently declared that the ultimate reality of the universe can be directly perceived, though never in normal consciousness. Esoteric teachings of all traditions contain four fundamental ideas:

When fullness is taken from fullness,
Fullness still remains." (Isha, invocation)

1. God (Absolute Reality) is.
2. God can be realized (experienced, felt and known immediately in the depths of one's one soul).
3. To realize God is the supreme goal of human existence.
4. God can be realized in many ways.

As long as people are intoxicated by their pleasures derived through sense-objects, they will have no desire to embark on a path of self-realization, leading to God-realization. The New Testament story of the rich young man who wanted to follow Jesus depicts the difficulties and trials, the obstacles made by the attractions of life, of the power of the phenomenon of life over people, especially over those *who have great possessions*.

"It is easier for a camel to go through the eye of a needle, than for a rich man to enter into the kingdom of God" (Matt. 19:24).

Rich in this context has primarily the idea of attachment, especially of the people possessing great knowledge, a great mind, a great talent, position, fame - all these are "riches" which close the entrance to the Kingdom of Heaven. Attachment to church religion and great theological knowledge is also "riches". Only if the "rich man" becomes "poor in spirit" does the Kingdom of Heaven open to him. Every scientist, no matter how brilliant and profound his knowledge of the nature of the gross material world, is also a very rich man, and as long as he is attached to his riches, he will not be able to enter the Kingdom of Heaven.

However, a moment will come when they will be aching with dissatisfaction with the unreality of the world, and suffering from the insomnia of the heart.

There are three basic methods through which it is possible to achieve liberation from all illusions and attain mystical union with our real Self:

1. Ethical living (abstaining from any kind of evil)
2. Practicing spiritual disciplines (meditation and non-attachment)
3. Through ingestion of special entheogenic ("lucidogenic") plants, such as sacred mushrooms (amanita muscarina, psylocibe mexicana) containing substances known as psychotropic, psychomimetic or hallucinogenic. Though they offer instant illumination catapulting one into inconceivable states of consciousness, they are not the preferred way! Their main usefulness lies in their proving to the doubting Thomases that the visible world of solid matter is not the only reality, but the real danger if used often is that the states of consciousness thus experienced are so incongruous with the state of mind of people who have not purified their personality that they can damage their nervous system.

In his revolutionary book on the nature of consciousness, "The Psychology of Consciousness" [18], Robert E. Ornstein, has shown how a synthesis of the two modes of knowledge can bring about "a more complete science of human consciousness with an extended conception of our own capabilities". His Postscript includes these sobering thoughts:

"After all our talk of synthesis, new work, new understandings, there remains a word of caution, addressed especially to those who work in science. It would be the height of absurdity if we were to settle, now, for a strictly intellectual understanding of the existence of a second mode of consciousness. The possible danger here is of a newer and more elegant reductionism, of feeling we have tasted the implications of the esoteric traditions simply by calling them 'intuitive education' or by some such term, of reducing them to words and logic once again.

The new possibility can go beyond this: to a confluence of the two streams of knowledge, the esoteric and the modern, in science and in each of us. This confluence cannot affect the contents of science unless enough scientists work in both areas of inquiry, both professionally and personally. We can achieve a more complete science of psychology, but only if enough people make the effort to train those aspects of themselves which are usually uncultivated in Western education. This book only begins to consider some of the very radical possibilities of the esoteric traditions. If it does anything, it will be to further an organic process of synthesis of the two traditions. By its very nature, such a synthesis must draw from the personal experiences, as well as the intellectual investigations of many."

So, we have now two alternatives. Either we must decide that there is only one kind of knowledge, limited to the objects of sense-contact, and thereby resign ourselves to a permanent agnosticism concerning the nature of ultimate reality and the teachings of the scriptures. Or we must admit the possibility of another, a higher kind of knowledge which is supersensory and therefore capable of confirming the truth of these teachings through direct experience. Such is the knowledge which is obtained through samadhi and theosis. And each one of us has to find it for himself.

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PSYCHOTHERAPEUTIC RITUAL IN AMAZON TRIBAL SOCIETIES

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Abstract. In the societies settled on the upper course of the Amazon river, hallucinogenes in the potion named Ayahuasca are used in the special psychotherapeutic ritual. The main person, the leader of the ritual is shaman, devoted to that proffesion by his own choice, of his own deep need for researching the modes to help the society he is living in. Therapeutic ritual itself is based on the experiences of his teachers and his own, and has a form of a special kind of treatment, special not only because of the tecnique, but, also, because of the purpose. Entering into the another reality world, visualizing and liberating individual and collective unconscious material, with shaman's and the group's support, patient is looking for the answers about his own personality, his place in the group and in the universe, and, at last, but not the least, for the protection, security and encourangement that almighty cosmic forces deliver to him. The shaman sends the patient on that trip, follows him, grasps and interprets all the events in that shifted consciousness state as the messages the altered reality sends. This is the way to correct the disturbed balance between the positive and the negative influences, that caused the illness or misfortune or even something worse. Bringing the patient back again to the community he finds supportative and removing the danger for one's or group's physical, spiritual, social and cultural integrity by re-establishing the harmony between them and cosmic powers is the purpose of the treatment and the condition sine qua non for a healthy individual and a healthy society.

Keywords: *shaman, hallucinogenic, transpersonal experience.*

The person, responsible for the activity called the psychiatric medical treatment according to the Western rite, is, in tribal societies settled on the upper course of the Amazon river [1], without any doubt, the shaman. He himself exclusively takes care of the group members and the entire group psyche integrity. To understand the therapeutic aspect of the shaman's activity, the most important is to be close with his special technique, the technique that is the essence of his competence and that makes him to differ from the others, similar categories, persons (jerbatero, the medicine man etc.). We are talking about the technique called by Mircea Eliade the Ecstasy technique or the Ecstatic state technique, or, perhaps more suitable, shamanic states of consciousness, by Mike Harner.

Anyway, we are talking about *the altered states of consciousness*, that the shaman reaches in the different ways and that enables him to enter the scope of his contacts with something Castaneda called a separate reality; that means, he preceives unusual reality manifestations, parallel to the everyday reality, but hidden, invisible, attainable only through the ecstatic state drama. By the shaman's universe and the world concept, in such an latent reality the Pantheon resides, the powers that posses

the absolute knowledge and the absolute force. To realize his mission, the shaman has to be an expert in finding the ways to reach the ecstatic state (that is, the shifted state of consciousness), in contacting another reality through that altered state of consciousness and, also, to understand the events in it, that means, to grasp and to interpret messages another reality sends to him. Hallifax claims that shaman's mission is, in fact, waking up to the another things system, the ecstatic experience and visual scope opening [2].

Another important element that distinguishes the shaman from similar tribal important persons is *the goal* of his trip to another reality. There are practical reasons for such a trip: to search for and to discover the cause of disease, to find the suitable medicine for treating it and to recognize signals threatening the individual or the group... On that occasion, he is dealing with the problem of the disease in a very broad context, considering it to be the negative forces (the Evil) effect that endangers spiritual, physical and social integrity of the individual or the group. It is important here to emphasize that in the observed groups mystic experiences appear through the therapeutic seances, but, in this context, it has solely practical importance, that means that nothing changes exclusively a practical importance of the shaman's trip to the altered reality. The mystic experience in this context has no religious background, but exclusive practical significance in the sense of looking for the human's place in the huge cosmic scheme.

The shaman, certainly, can participate in the religious rituals, but, it is not the main goal of his activity. His main task is to make a contact with the world of another reality and in such a way to achieve some practical gains important for the whole society. The relationship with the forces possessing the absolute knowledge and the absolute power he makes contacts with, is still another characteristic of Amazon societies shamans. Regardless of the intensity of this relationship, the essence is in fact that the shaman never undergoes their influences. *He is never possessed*. The shaman is always his own. He is the one who knows, the interpreter of the hidden, an expert for the communication with the Pantheon. In the observed groups, no idea of possession was noticed and there was nobody who could even explain what possession means.

There is another characteristic of the Amazon territory shamans that makes them unique. In contrast to others, in the first place Asian and Australian shamans, who were "called for" by delivering "from above" during their illness or the dreams, or who became shamans by succession, Amazonian shamans devote themselves to the profession by their own will. The decision to become a shaman is their own choice, the consequence of the filling the deep need for the "great search", for researching the hidden cosmic spaces, internal or external. It is understood that such a decision makes shamans insulated in some way and may be the reason for some investigators to proclaim the elements of psychopathic structure in shaman's behavior, neurotic arrangements or even psychotic conditions. Those kinds of assumptions have no reason, at least concerning the shamans in the upper course of

Amazon river. Investigating shaman's psychotherapeutic rituals we have noticed no apparent psychotic or psychopathic behavior among them.

Concerning the first demand related to attainment of the ecstatic state which is the prerequisite for penetrating the world of altered reality, the Amazonian shamans, following the traditions of their psychedelic culture, use solely psychotropic potions. Keeping in mind the inexhaustible possibilities offered by the surrounding flora, it is quite understandable. The use of psychotropic herbs is the most dramatic and perhaps the most dangerous one, but, undoubtedly the most effective way to reach the shifted states of consciousness and to enter the "another reality". But, a more difficult task is to understand the symbols and messages delivered from that world and solving such a task is attainable exclusively to the exceptional ones. This kind of knowledge the shaman acquires in two ways. In one way, the shaman teachers deliver knowledge to future shamans during mounts and years of intensive training under the conditions of deep asceticism, and in another, the shaman himself enriches that knowledge by personal experience acquired on his solo trips. The shaman has to be the expert in other reality's morphology through which he is moving together with the creatures he meets, so that he would be able to identify them and to translate their messages. The specific meaning that these creatures' movements, their language, the mode of appearance and vanishing always is of great importance that is necessary to be understood. All the events that the shaman recognizes have their own meaning and the teacher clues him in it. Without that key, everything seems to be chaotic, unintelligible, indistinct and deterrent. Understanding the events in that world, recognizing pictures that arise, creates a system and puts order in the chaos, structures it and gives a meaning to it. So, the shaman has to learn how to manage, deal with and to understand that world in the same way he is managing, dealing with and understanding the common world his group lives in.

Alone, or accompanied by other members of the group, the shaman immerses himself into hallucinogenic experience during special rituals, entering from one state of consciousness into another (that is, from the common state of consciousness to the shamanic state of consciousness). So, he reaches "another reality" where he tries to find the cosmogony and theogony echoes of the group he belongs to, using his own experiences and the knowledge his teacher gave to him, and, in that context, to interpret to himself and his companions the messages delivered from that reality. All the members of the observed group are allowed to take psychotropic potion, that is, to enter another reality, but the shaman is the only one that understands and interprets that reality.

There is not enough place to describe the ritual itself, but, intending to make some decor of the situation, we will mention only that five to seven selected people, "the patients", that the shaman has carefully chosen before, together with the shaman himself and, eventually, his assistants, take part in the ritual. The whole ceremony happens exclusively at night, at special, for that purpose determined places, outside the village or at it's edge. Psychotropic agent is the potion known as Ayahuasca, not

yet quite identified. The main ingredients of the potion are the plants from Malpighia family: Banisteriopsis caapi and Banisteriopsis inebrians, both of them the jungle lianas, but, besides those plants, Ayahuasca contains a great number of other ones, chosen carefully by the shaman, depending on his own knowledge, experience and the goal he wants to achieve. Some of those herbs are identified (Psychotria viridis, Banisteriopsis rusbiana), but, most of them are not. The main chemical compound is alkaloid harmin (the ingredient of Banisteriopsis caapi), but, the other compounds are not chemically identified yet. The ritual itself is rather complex, but, it is impossible here to consider it completely, regardless of the importance of its anthropologic and psychotherapeutic implications. The crucial thing of the ceremony is the drinking of Ayahuasca that happens one hour after the ritual begins. Ayahuasca effects are expected about one hour after, sometimes more, depending on the type, dose and the purpose of the potion given to the patient.

It is necessary to mention, once again, that in these societies consciousness is experienced as the balance between the positive and the negative (evil) forces. When this balance is thrown off towards the negative forces, misfortune, illness and death occur. So, illness is considered in a very broad context, as exposing to a danger not only of one's or group's physical, spiritual or social integrity, but their cultural integrity, too, and, also, as the disturbance of their harmonious relationships with the cosmic powers. Such a view of disease makes the shaman, as an expert in supranatural sphere and cosmic space interpretation and comprehension, not only more responsible, but, also, forces him to work on several levels, from a selection of snake bite balm to the situation when he is expected to be acquainted with the answer to the questions such as: who am I, what am I, or what's my place in the Universe? According to the described comprehension of the disease and the treatment in the observed groups, we are permitted to designate a few shaman's work domains and to define them as following:

- empirical-rationalistic (phytotherapeutic, first of all)
- magical
- social
- psychological
- transpersonal or integrative.

It is clear that all the shaman's work levels overlap, so that it is hard to distinguish them at a first glance, but, therapeutic act contains the totality of them and they can be followed as the therapeutic entities. We are going to leave aside the first three levels here, that means, the empirical-rationalistic, magical and social context of the therapeutic management and not to consider their importance for understanding the entirety of shaman's therapeutic actions.

Those psychotherapeutic group ritual aspects that are unfolding as open, specialized and directively guided group, use the disleptics to reduce self-defense, to make it easier to throw the repressed contents out and to facilitate the

communication between members of the group, to magnify the suggestibility in the relation to the leader and to expand the insight. Disleptics are, also, of great importance in the therapeutic sense, but, it does not enter the scope of this text nor corresponds to its aim, so, we are not allowed to dwell more on them.

In our work we emphasize those implications of the shaman's action that have therapeutic aspects that encroach the domain of transpersonal psychology.

The most impressive part of the seance is, of course, the appearance of the visual contents under action of the hallucinogenic potions. The patient is overflowed with pictures he does not understand so that he is forced to turn to the shaman, to call the tradition and the myth for explaining these events to him. The appearance of these pictures offers plenty of possible interpretations and the opportunities for reaching their meanings, too. Those meanings will differ if observed from the point of view of a theologist, psychologist or psychiatrist. The last one has his own variants, depending on the professional ideology he accepted. So, without maintaining at the different theoretical aspects, we'll mention only that the most of the therapists dealing with the psychotherapeutic effects of the hallucinogens consider the hallucinogenic experience as the authentic subconscious material that emerges on the surface in the form of pictures after the defensive walls destruction. If we accept that the visual contents that dominate in the Ayahuasca session are the subconscious material manifestations [3], then the shaman makes some kind of cultural arabesque by projecting the subconscious content to the supranatural sphere. His interpretation places patient's subconscious contents into the cultural content attaining in that way different results. In the first place, the patient avoids painful meeting with his own consciousness. Instead of the confrontation with himself, there is a meeting with the world of the ghosts. And no matter how horrible that world is and those meetings unpleasant, disturbing and frightening, it is still much easier to meet it than to confront with oneself, especially when crossing that world with the guide help and the group support. We could, perhaps, say that the patient got some kind of insight, but, a culturally determined insight, modified, less painful and culturally more acceptable. The internal danger is projected to the external space. Supranatural world becomes a marvelous vault of the subconscious contents in that way. The shaman is capable of recognizing wishes, fears and needs placed in that vault and of interpreting them according to the group's cosmogony and theogony. It can be supposed that at least some of the pictures are explicitly individual ones; those pictures enable the shaman to create the base for interpretations of his fellow tribesmen's problems.

Nevertheless, the most significant dimension of the hallucinogenic experience, the experience that, practically represents therapeutic essence in the isolated Amazon groups, is the dimension that touches universal themes, from the questions about the personal identity to the question of his place in the cosmic model. This experience, described as transcending boundaries of the entire reality experience, as going beyond the profane living framework, penetrating the cosmic existence sphere

and going toward the highest principle, is often called the transpersonal experience in the literature, to differ from religious terminology that denotes it as a mystical experience.

There is still a question about the characteristics of such an experience and if it even exists in the shamanic concept, because many shamanism experts (and Eliade among them) didn't find such mystical component in the concept that is directed solely towards the practical use.

According to the shaman's practice, these categories do not exclude each other and the mystic or transpersonal experience is directly related to the function of the treatment, if the treatment is carried out in the context that corresponds to the shamanic concept of the illness. No matter how defined the mystic experience, it's clear that it leads to the experience of the direct contact with the highest forces, to the "communication with the nonconditionated world" [4] or, quite concise, to the "realization of the relationships between someone's consciousness and the Absolute" [5]. In the ecstatic state the shaman tries to make a contact with creatures that possess the absolute knowledge and the absolute power, crossing cosmic spaces. Through these contacts he tries to get the answers to the questions like: who am I, where am I from, to whom I do belong, where am I going to, what's my place in the Universe? – the questions that lie in the base of every mystic search. In such a context, shaman's trip, based on searching for the absolute, has, without any doubt, mystical elements. The mystical, nevertheless, does not exclude the practical purpose of this trip. Quite the oposite, mystic or the transpersonal experience is complementary with this aim. In other words, this experience is in the immediate function of the purposes of the shaman's action, and in the first place, for the purpose of treatment. As one is "constantly coming back to his mystic, transsubjective roots and to his beginnings" through these experiences, the trip from here and now to there and then is quite understandable; the same is true for one's coming back to the myth past and the dramatic contacts with the myth scenes and symbols, through which one realizes important human connections with the cosmos. Following the idea of the unconscious contents liberated by the influence of the psychotropic substances, it could be supposed that on this level the deeper layers of the unconscious material are released, the layers that belong to the collective unconscious material. This would be related to already mentioned assumption that some hallucinogens in defined doses wake certain layers of the unconscious material up [6]. The transpersonal experience in this context would correspond to the waking archetypes contents up, the contents whose origin is so deeply buried in the mystery of the past that it seems that they have no human origin.

It is possible to observe the whole thing in another way, a way that seems very logical and acceptable, because it is not based on hypotheses and speculative arrangements, but on some objective details that cannot be avoided in this context. First, it is important to keep in mind that psychotropic substances, including hallucinogens, influence the brain parenchyma, and not the perceptual and emotional

contents of the mind. So, it can be said that those substances modify the synaptic transmission, that means that hallucinogenic drugs "modify the brain, not the soul". Such a modification would be reflected to the psychological acts and ongoing activity connections, relaxing and destroying them. In other words, there may be some kind of splitting: imaginations, feelings, thoughts etc. escape the immediate and often unpleasant reality control. So, we could talk about hallucinogens that liberate the brain from a great number of stimulation and information that the reality imposes on the human. The consciousness regarded as a function of the central nervous system becomes free from the tyranny of the ongoing reality. By closing the immediate reality information conducting channels, hallucinogens release the consciousness, so that released consciousness is capable of distinguishing everyday problems and actual questions and concentrating to the universal questions. Universal questions, from an individual point of view, are those that denote one's relationship to oneself, to the group and the universe. So, everyone's consciousness begins with the relationship to he himself, that means, the consciousness about oneself. The next important relationship is the one towards the group, and the third level is the relationship to the universe.

By lowering down the intensity of the ongoing reality or making it disappear together with its meanings, the spiritual world becomes the only and true reality. In such a reality, the shaman or his companion transforms into the thinker confronted to himself, his group and the universe. In common life, he may be without the consciousness of the individual, group or cosmic symbols and concepts, or, better, he may not catch the ability to operate them. Hallucinogens that eliminate disturbances originating in the ongoing reality, revives the contents that would remain, probably, hidden forever and out of the individual consciousness without the shaman's help. They (hallucinogens) disturb the realistic consciousness, but release the spirit. In other words, during such an experience, the "primitive hunter" changes into a thinker who is looking for the lost spiritual balance, not during the practical act he is used to, but in the spiritual strain that has to integrate him with the world he depends on and the universe he is the part of. Acting on the described way, hallucinogens make an individual capable of entering the world of visions, memories, fantasies and dreams. Such experiences (visions, pictures, memories), can be, on the one hand, products of the individual experience elements, but, on the other, of the processes common to all people. By this concept, if there is anything that exceeds all the limits of the individual knowledge representing the property of the collective, mankind, then it has to be the activity built up of some psychological operations. Using the delivered knowledge and personal experience as the base, the shaman makes the decision which, from the awoken pictures, is the individual experience, and which is a result of the common psychological processes and adapts his therapeutic attitude to them. On this therapeutic measure level, shaman potentates hallucinogens properties to "turn the consciousness" from the actual happenings in the normal reality towards "another reality", the spiritual world, leaving the patient to his adventure and following him on this travel. It was already mentioned that such a trip contains three

important levels. The first level is represented with the relationship to oneself and contains questions such as: who am I, where am I from, where am I going, to whom do I belong, how can I survive in this world? Here, the central theme is one's own identity. But, investigating one's own identity makes the next level closer and easy and fast to reach so that often it is impossible to separate them. On this second level, the most important personal dimension exists: the individual relationship to the group. In Machigenka Ayahuasca group it is said: "Ayahuasca is something that is consumed... it shows you where you are from, where all Machigenka are from, Machigenka that were and that are...Then you know that nothing can happen to you...". On this level, the comprehension of the things order is crucial, that means, in such a context it is necessary the way of clan operating and the individual needs to be settled in the structure of the clan, the society structure. Only when he finds himself integrated, one dares to meet the absolute forces. Shaman's aim is to direct his patient to a close contact with the forces that possess the absolute knowledge and the absolute power. Questions about cosmic forces, absolute, deity, do not originate from academic needs to understand the time and space infinity and the origin of the Universe, but are the expression of the impossibilities and needs for protection, security and encouragement. All the thoughts about time, the origin and the infinity are based on the invincible human need for security and support. The shaman is, of course, more curious than his fellow tribesmen and more confident in the search for almighty cosmic forces, but his own deep needs for the knowledge about the beginnings and the ultimate meaning of everything have the same base: the need to be protected, supported, encouraged, and his effort to connect his personal meanings with the meaning of the universal order, to find his place in the great cosmic model and, once again, in that way to affirm the fact that he is integrated into the absolute power's world because without such an integration his fortune and the fortune of the whole group will be denied to the helpless human beings; all those efforts have the same purpose. His therapy is directed to the same aim: to make the contact between his own people and the absolute powers and to assure them by the immediate experience, that those forces are friendly and omnipotent.

Reaching this level, the individual and the group identities acquire a definite value and it brings the selfconfidence and the selftrust back. From the shaman's point of view, it is quite irrelevant if the cosmic forces he contacts are revived from the collective consciousness and the long time ago buried experiences, or their base is universal psychological processes elaboration. We could take this theme for our thoughts and the professional ideologies, but, for the shaman, it is important only that these forces exist on the level of another reality, that authentic communication with them is possible and that they can be reached by changing the normal into the "shamanic state of consciousness", so that they can be lived and that his people can be ensured in their friendliness and protection. That is the crucial place and the substance of the shaman's cure.

Acting therapeutically, the shaman uses common and global forces, such as: the community and the higher (gods) powers for solving individual problems. Going from the common to the individual, the shaman begins from the most common collective consciousness to apply it on the individual case. It differs from the psychiatric treatment in that psychiatrist takes the individual case, the individual and his responsibility and tries to make him capable and adjusted to the common and general demands. Native culture member regards the general as the ally, friendly and supporting, but in the Western culture, the individual and common are regarded as confronted forces that he cannot cope with.

We'll repeat, once again, that the essence of the shaman's therapeutic procedure could be interpreted in many different ways, beginning with the already mentioned ones that we found acceptable for explaining this phenomenon, to the very exciting concept of the "biophysical model for altered states of consciousness" [7] that is still waiting for its place in the current intellectual jargon. So, interpretations depends upon one's professional, philosophical and even religious views. The shaman himself will, however, remain indifferent, carrying out efficiently his psychotherapeutic job in the scope of his experience of the human, the world, and the universe.

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NEUROLINGUISTIC PROGRAMMING: AN INTEGRATIVE MODEL FOR STATES OF CONSCIOUSNESS

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Abstract. Reality is universal, but our experience of reality is individual, and differs between human beings. By using different models, people can limit or expand their experiences. Neuroliguistic Programming (NLP) is one of the many possible ways to change old behavioral models. Physical disease, psychological problems, educational and/or spiritual needs, are seen in NLP as part of natural developmental mechanisms. The need for change and the search for new resources (e.g. biological, psychological, cultural or spiritual) allow people to expand the richness of their experiences, knowledge, and consciousness.

Keywords: *behavioral models, states of consciousness, neurolinguistic programming (NLP), integrative model.*

1. INTRODUCTION

Reality is universal, but our experience of reality is individual, and differs between human beings. Every individual, as a unique biological, psychological and sociological human being, creates his/her own representation of reality, which he/she then uses as a model to generate behavior. By using different models, people can limit or expand their experiences. Our choice of a specific model of reality is based upon our individual experiences – our unique personal history. The models that we choose in our life to represent the world will in turn create specific psychological structures; e.g. our interests, habits, likes, dislikes, and rules for personal behavior.

Some models of reality that we have developed in the past under certain circumstances are no longer useful in our life. *Neurolinguistic Programming* (NLP) is one of the many possible ways to change old behavioral models. These outmoded strategies impoverish our experience, and limit our ability to act effectively in new circumstances. Certainly, our unconscious body/mind processes can operate in an intelligent, autonomous, and creative way, for we have stored in our unconscious all the resources necessary to transform our experience. Everyone has an opportunity to set aside his/her identification with any limiting conscious processes, and can shift into a context where he/she may access and utilize unconscious biological and psychological resources for therapeutic gain.

Physical disease, psychological problems, educational and/or spiritual needs, are seen in Neurolinguistic Programming as part of natural developmental mechanisms. These mechanisms have been used in an attempt to adapt to certain environmental conditions. Every person has the potential for change. This potential is part of his/her natural survival mechanism. Although some people may have limited resources, these potentials for change constantly exist in their bodies and minds. For every single person, there is always the next developmental step that can be taken. The need for change and the search for new resources (e.g., biological, psychological, cultural or spiritual) allow people to expand the richness of their experiences, knowledge, and consciousness.

2. NEUROLINGUISTIC PROGRAMMING - MODELS

There are several models of NLP: integrative, biophysical, sociological, psychological, and hypnotherapeutic ones.

2.1 Integrative Model

The *integrative model* of neurolinguistic programming has been developed by Gordana Stanojevic-Vitaliano [1]. This model is centered upon the integration of four different models:

1) *Biophysical Model,* for the analysis of body functions (e.g. health status and organ functions);
2) *Sociological Model,* for the analysis of behavioral functions (e.g. nonverbal and verbal communication);
3) *Psychological Model,* for the assessment of psychological functions (e.g. attention, perception, emotion, motivation, motor functions, language and intellectual abilities);
4) *Hypnotherapeutic Model,* for therapeutic intervention.

2.2 Biophysical Model

Our nervous system, initially determined genetically, constitutes the first set of filters which distinguishes external reality from our internal representation of the world; i.e., our experience of reality. There are many physical phenomena which lie outside the limits of our five biological sensory channels. For example, sound waves either below 20 cycles per second or above 20 000 cycles per second cannot be detected by human beings. Also, our visual system is able to detect wavelengths lying only

between 380 and 680 nm. Thus, our genetically-given neurological limitations allow us to perceive just a small portion of a broad range of continuous physical phenomenon.

Our brain processes huge amounts of information that is continually coming in from our senses. We become aware only of a very small portion of the data processed and stored in our brain. The most important information reaches our consciousness every 0.1 sec [2]. The whole process of sensory data analysis and synthesis is completely outside our awareness. Our brain is systematically distorting and deleting sensory data coming in from the outside world. Thus, what we experience as the 'real world' is just our representation, or personal map of world that differs from the world itself. This internal process was recognized a long time ago, and has been described as "Maya", or illusion, in the Indian tradition.

The *biophysical model* used in neurolinguistic programming allows us to monitor and measure individual biological abilities and physical limitations. Modern technology significantly improves our ability to identify and correct problems in body functions. Further monitoring of the course of recovery enables us to develop more specific strategies and alternative therapeutic programs.

2.3 Sociological Model

The second set of filters – social genetic factors – serve to distinguish us from each other as human beings in relation to social-ethnic membership. The social genetic filters are similar for all of the members of the same social-linguistic community (e.g. language system, the accepted way of perceiving things, socially accepted rules).

Our experience of reality and our choice of language used to describe it is influenced by the surrounding environment. For example, Eskimos have 70 words for snow, while English speakers have only one. While human beings are capable of making 7 500 000 different color distinctions in the visible color spectrum, people who are Maidu native speakers group their experiences into only three categories: lak (red), tit (green or blue), and tulak (yellow, orange or brown). They are aware of only three categories of color experience. For example, they do not recognize the difference between a yellow pot and brown pot.

Socially accepted rules of normal behavior in different communities are different. In the Masai African tribe, the traditional custom is to drink human blood. In Western cultures, a person who drinks human blood is generally considered to be schizophrenic or crazy. His reality is thus deviant to the generally agreed upon reality. Anthropologists studying a new culture are often forced to confront their unconsciousness presuppositions. Their hidden beliefs may become conscious only after encountering a social world that violates them.

Our ability to incorporate new knowledge depends in great part on whether the new information fits into what we think is true about reality. When we hear new information, our

unconscious context greatly influences the manner in which the novel conscious information is processed. Our ability to learn and process new information is thus critically dependent on our prior, largely unconscious, knowledge. The more we know, the easier we learn.

The *sociological model* in neurolinguistic programming uses specific communication models to analyze and indirectly change malfunctional behavior. The verbal and nonverbal communication between client and therapist is the most important factor in the healing process. Careful analysis of the client's language (e.g. words, phrases and sentences) and nonverbal behavior (e.g. facial expressions, eye behaviors, gestures, postures, and intonation, volume, tonality and tempo of the voice) is necessary for understanding the person's model of the world. The "pacing" of the client's verbal and nonverbal behavior in therapy is the basis for "leading", i.e. introducing new behavioral models. These methods enable quick shifting between the external sensory mode of information processing and the internal imaginative mode of cognitive processing. The new information can be easily channeled through different modes of data processing, which, in turn, allows reframing of the common ways of seeing, hearing, or feeling things.

2.4 Psychological Model

A third way in which our *experience* of the world can differ from the world *itself* is through a set of filters we call psychological individual constraints. By psychological individual constraints, we refer to all of the representations we create as human beings based upon our unique personal history. These unique maps we create in the course of our life constitute a set of interests, habits, likes, dislikes, and rules for behavior that are distinctly our own. Even in the case of identical twins, their unique experiences as individual persons will give rise to differences in the way they create their own models or perceptions of the world. Our individual differences can either be ones that alter our perceptions in such a way that they enrich our experience and thus offer us more choices, or can be ones that impoverish our experience in a way that will limit our ability to act effectively.

The *psychological model* in the neurolinguistic programming, by using a testing procedure which is operationally defined, repeatable, and quantifiable, allows us to measure, describe, and quantify specific psychological aspects of individual behavior. This procedure accomplishes the following: (a) It allows the practitioner to correlate brain and behavior functions; and (b) It provides new insights into the relationship between biological and psychological functions.

The psychological model is focused not only on the global characteristics of certain behavior (e.g., attention, perception, language, cognition), but also on the specific behavioral strategies being used in the problem solving procedure. The precise, careful documentation and quantification of psychological functions and

behavior enables better understanding of individual strengths and limitations, and encourages the appropriate choice of therapeutic intervention.

2.5 Hypnotherapeutic Model

The *hypnotherapeutic model* in neurolinguistic programming is designed specifically for each individual. The application of the hypnotic methods is based upon the subject's personality, attention/cognition abilities, dominant mode of information processing, emotional and health status, and behavioral strategies. Hypnotic induction includes the most commonly used techniques, such as a visual, auditory and movement imagery, storytelling, ideomotor techniques, progressive relaxation, distraction and confusion techniques. The use of trance phenomena in hypnosis enables the alteration of psychophysiological functions and to change states of consciousness.

In hypnotherapy with neurotic patients, we mostly use symbolic techniques, metaphorical stories, and different types of imagined events to indirectly produce positive changes and to reduce malfunctions. The applied multi-modal, multi-media methods enhance hypno-therapeutic effects through audio-visual-kinesthetic channel activation, and verbal and nonverbal feedback communication. One example is the "anchoring" technique, which was successfully used by this writer with a patient who had a panic disorder. In this case, we 'anchored' the body signals of panic attack on the patient's right shoulder; i.e., every time the subject had a panic attack, we touched his right shoulder. Similarly, we anchored the relaxation response on his left shoulder.

Once so anchored, we could produce a panic response merely by touching his right shoulder; and conversely, produce a relaxation response just by touching his left shoulder. Then, by simultaneously touching both his shoulders, we deliberately created an internal confusion. This mixed internal signal produced a substantial reduction of the patient's anxiety symptoms [3].

3. NEUROLINGUISTIC PROGRAMMING - APPROACHES

There are several approaches to NLP: integrative, direct, experimental, and indirect ones.

3.1 Integrative approach

The *integrative approach* to hypnotherapy [1] uses the most important procedures described in the three historically different approaches to hypnotherapy. It is centered upon the integration of the following three approaches:

(1) *Direct approach.* This is applied in the analysis of the effects of hypnotic treatment on body functions. The biophysical method allows us to measure the concentration of ions and electromagnetic field around the human body. This approach is focused on determining the role of both energy and information transfer in the therapeutic processes.

(2) *Experimental approach.* This is used in the assessment of psychological functions (e.g., attention, perception, emotion, motivation, motor functions, language and intellectual abilities) not only before and after the hypnotic treatment, but also during the trance state. The psychological model allows us to measure and compare the changes in psychological functions that occur in normal and altered states of consciousness.

(3) *Indirect approach.* This is focused on the analysis of the patient's verbal and nonverbal behavior; which behavior can be used to alter his state of consciousness and to access his unconscious mind. The sociological model allows us to measure observable changes in behavior functions before, after, and during the hypnotic treatment. It also helps us to determine behavioral characteristics of altered states of consciousness.

Thus, the integrative approach in NLP considers all three different approaches to be valuable in hypnotherapy. The integrative approach includes the most important diagnostic, therapeutic and research procedures used in these approaches. This is especially important, because the biophysical and psychological effects of hypnotherapy in neurolinguistic programming have not been thoroughly researched. Also, the biophysical, psychological and behavioral characteristics of altered states of consciousness are still unclear.

3.2 Direct approach

The *direct approach* to hypnotherapy emphasizes the power of the therapist. According to this approach, an authoritarian therapist has some special ability that can influence another person's health and well being. In the 18th century, Mesmer believed that he possessed cosmic fluid or energy that he called "animal magnetism". He believed that he could heal people by hypnotizing them with his special energy. He was discredited as a charlatan by the French Academy of Science in 1779, but his theory remains as the first scientific effort to explain healing phenomena [4].

Mesmer's approach continued to be used in the 19th century by many hypnotists. Only the theory changed. Instead, the therapist now possesses a power of suggestion that can influence patient's brain (Braid, 1843). In its most extreme form, this theory involved a charismatic, strong willed hypnotist (usually a male) exercising his power of suggestion over some helpless and weak-willed subject (often a female) in order to heal her hysteria. This direct approach model was developed by Charcot in 1878 in France, and is still exploited by stage hypnotists.

This stage act is often misinterpreted by lay persons as being an accurate representation of clinical hypnosis.

The direct approach generally assumes that the patient is completely passive, and that hypnotherapeutic energy "cosmic fluid", or information "suggestion", can be easily transferred from the therapist to the patient. It was believed that either biological or psychological influence produces a permanent physical change in the patient's body. The patient was fully open to receive transferred energy or information, which directly influenced his/her brain or the whole body. The problem still remains how to objectively prove the existence of bioenergy and measure the changes in the human body. The limitations of this approach in therapy are that direct suggestions usually do not work very well, and that people often do not like to be told authoritatively what to do.

Freud was the first to recognize the limitations of this power of suggestion approach. He not only criticized the direct approach, but hypnosis generally, and was the first one who shifted the focus away from the therapist onto the therapeutic process itself.

3.3 Experimental approach

The *experimental approach* was developed in part as a reaction to the misplaced value of the direct approach devolving on the power of the therapist. In the experimental approach, the emphasis is on standardized hypnotic suggestions. The experimental approach generally assumes that hypnotic responsiveness depends on some inherent trait or ability of the subject. The hypnotist is less important. The subject is one who is either hypnotizable or not. In order to objectively measure the individual's susceptibility to trance, the experimental approach uses repetitive suggestions in conjunction with psychological tests, such as hand immobility or heaviness. If the person passes the items on the test, he/she is considered to be hypnotizable, and the standardized suggestion will have beneficial effects. If the person is not responsive enough, then he/she is considered not to be susceptible to the phenomenon of trance, and hypnosis will not have any effect.

The experimental approach was developed at the beginning of the 20th century [4]. The psychological value of repetitive suggestion was first emphasized by Bernheim and Liebault in 1888. These two were the founders of the first school of hypnosis in Nancy-France. Their tradition continued on at the beginning of the twentieth century via the second school in Nancy as organized by Emil Koue. His work was totally focused on the power of repetitive suggestion, with a special emphasis on autosuggestion. For Koue, the role of hypnotist was considered to be unimportant. Psychological influence was achieved through the effects of repetitive suggestions on the patent's mostly conscious mind. This approach is very popular

even today. The only difference is that such suggestions are now put onto audio tapes that can be played (almost) at any time.

The experimental approach is a valuable model in the research setting when it is necessary to standardize certain therapeutic procedures. However, it does not work very well for many subjects, especially in clinical settings. The experimental approach interprets the large percentage of unresponsive subjects as evidence that some people are not susceptible to hypnotic trance. But the unresponsiveness of some patients is probably more a reflection of the limited procedures being used, than the actual unhypnobility of the subjects. Hypnosis is a subjective experience whose behavioral manifestations greatly vary across individuals. The experimental approach does not pay attention to the individual characteristics of hypnotic behavior, nor is it interested in personal experiences while in hypnosis. The standardized hypnotic induction is usually poor in quality, and often uses only simplistic relaxation procedures. The subject's role is only to fit into certain predetermined procedures that are considered to be most important. The experimental approach cannot utilize nor handle the psychological difficulties that can often prevent a subject from entering into a trance (such as fear of being hypnotized, fear of losing control, fear of being hurt, or not being able to come out of hypnosis).

3.4 Indirect approach

The *indirect approach* is based on the Ericksonian approach to hypnotherapy [5]. The Ericksonian approach has been described by Bandler and Grinder [6] in their books about NLP. They carefully monitored Erickson's work, and created the model that explains the main principles of process oriented hypnotherapy. Ericksonian hypnotherapy is an active, goal oriented, carefully considered, ongoing creative process. Process-oriented therapy is a strategically planned indirect approach, focused on performing just one step at a time. The major focus in process oriented hypnotherapy is the subject, his/her personality, health status, attention/cognition abilities, and behavior/emotional status. The therapy is not focused on what the subject has done in the past, but what he/she can do now, and in the future. The change in the subject's behavior is based not only on the disappearance of the problems, but also on the creative use of new strategies in life. The indirect approach assumes that each person is unique in terms of the strategies used to create his/her own experience, and that effectiveness in therapy depends upon how well the therapist can adapt his strategies to those of a given subject's. The hypnotic process is a cooperative effort in which responsibility is mutually assumed. The therapist's task is to guide and supervise the subject. The subject's task is to decide if, how, and when to respond to the therapist' s communications. Within the continuous feedback loop of interaction, the therapist closely observes, accepts, and utilizes the subject' s ongoing verbal and nonverbal responses. The therapist assumes that all experience is valid; and it can be behaviorally transformed into the desired state.

The therapeutic goal is to change old maladaptive behavioral functions by using existing individual resources, and by developing new psychological structures. The new structures will be different from, but consistent with, the subject's present state, and much closer to the subject's desired state. The most important principles in the indirect approach are: (1) The *acceptance and utilization* of the client's reality; and (2) *Pacing and leading* of the subject's behavior. The process of accepting and utilizing is based on clearly communicating to the subject that what he/she is presently doing is fine, and that it will allow him/her to do something else. The new psycho/biological balance is created by "pacing" and "leading" the subject's verbal and nonverbal behavior. *Pacing* (the feedback of the subject's experience), is the basis for *leading* (a change of the dysfunctional model). This change is enabled by weakening the old "strong structures", and enhancing the new "weak potentials". The new potentials expand the richness of the subject's experience and offer him/her more productive choices in life.

The indirect approach assumes that every person has internal resources necessary to transform his or her experience. These internal resources are unconscious and can operate in an intelligent, autonomous and creative fashion. Thus, every person can set aside his/her identification with any limiting conscious model of reality and shift into a context (e.g. hypnotic trance) where he/she can access and utilize unconscious resources for therapeutic gain. Verbal and nonverbal communication are being used in therapy to alter the state of consciousness, and to create changes in the patient's behavior. Compared with previous approaches, the major focus in hypnotherapy shifts from the mostly conscious superficial process, over to the patient's deep unconscious resources. The direct influences of repetitive suggestions are actually being released by the indirect effects of both verbal and nonverbal communication on the patient's unconscious mind while in an altered state of consciousness. Thus, the indirect approach has significantly reduced the patient's resistance to hypnotherapy; as well as improved the rapport between the therapists and the patient. The majority of patients can easily access the trance state because the whole process seems flexible and natural. The indirect approach is a simple and effective model for hypnotherapy. However, there are some limitations: the different levels of consciousness have not been standardized, and the effects of Ericksonian therapy have not been well researched. The nature of altered states of consciousness, used in this approach, is unclear, and has not been thoroughly analyzed.

4. NEUROLINGUISTIC PROGRAMMING - LEVELS

The central task of our new integrative NLP model [1], whether experimental or applied, is the understanding of the nature of human consciousness. In order to understand normal and altered states of consciousness, this model explores different,

relatively separate areas of human behavior (for example, the areas of perception, of learning, of language, of cognitive processes, and of motor skills). Consciousness manifests properties that are para-conceptual by our ordinary concepts of space and time, and so require understanding in their own terms. As our understanding of these different areas of study in psychology grows, we continue to uncover the structures of human consciousness.

In the past few decades the West has witnessed a growing interest among scientists, psychologists and philosophers in what Ken Wilber [7] has called "perennial psychology" - a universal view as to the nature of human consciousness. The purpose of this psychology is to develop a universal model of consciousness which integrates western and eastern philosophical doctrines and experiential practices.

The core insight of the perennial psychology is that human consciousness is a multi leveled manifestation of a Universal Consciousness. Each level of the spectrum is characterized by different and easily recognized sense of individual identity. A man can identify himself with the Universe and have a feeling of supreme identity with the Cosmic Consciousness; or can focus only on his egoic tendencies and have an extremely narrowed feeling of identity related to ego-consciousness. There are numerous levels or bands of consciousness, described by different authors. We are presenting eight major levels in our hierarchical integrative model of consciousness.

The perennial psychology proposes that the various levels of consciousness (except that of Universal Mind itself) are the products of dualism [8]. The dualism is the act of severance, cutting (*con-scire*) of the world into seer and seen, knower and known. The threefold meaning of consciousness is coming from the Latin words *con-scio* that is to cut or make a distinction, and *con-scire* to know. The original dualism is presented in mythology as the separation of heaven and earth, male and female, and sun and moon. In epistemology, it is the separation of subject and object, observer and observed; while in ontology it is presented as the separation of self and other, organism and environment. With the occurrence of the primary dualism, man's consciousness shifts from the nondual mind to his body.

4.1 Perceptual level

Man first identifies himself with his body that exists in space and time. That is, the level where the line between self and others, organism and environment, is becoming established. Out of the oneness of Universal Mind, the perceptual level emerges. Man becomes aware of his body separated from the environment. This knowledge simultaneously creates awareness of space – the primary dualism. The primary dualism has been investigated by anthropologists concerned with the period in human evolution when man first learned to separate himself from his

environment. Also, it has been described by psychologists who have studied infant development as the period when the child learns to separate himself from his immediate surroundings.

During the first 6 months of life, the self is identified with its environment and, especially, the mothering one (Mahler's "symbiotic phase", [9]). The new born infant cannot clearly differentiate himself as a separate subject from his environment because the brain structures necessary for this process are still not developed. Most of the time, the infant is in deep sleep. At the age of six months, the infant is becoming aware of his body and can recognize himself in the mirror. The self, basically as a sensorimotor and instinctual body, has differentiated itself from the environment.

The Perceptual level includes the first set of filters called *biological filters*. Our nervous system with its sensory organs, initially determined genetically, constitutes the first set of biological filters which distinguishes external reality from our internal representation of the world, i.e. our experience of reality. Our genetically-given biological limitations allow us to perceive just a small portion of a broad range of continuous physical phenomena.

Self development is followed by the development of the central nervous system. The functional specialization of the neural structures is associated with the process of myelinization of the brain structures. In the first 6 months of life, there is a myelinization of the Reticular Formation, which is responsible for the state of arousal; and the Primary zones of the brain's cortex, which are responsible for the development of the perceptual skills. The neurons of the primary sensory system respond only to narrowly specialized properties of sensory stimuli (e.g. shades of color, the character of lines, the direction of movement, and the loudness of sound) and preserve their strict modal specificity [10].

The Perceptual level is the level of altered state of consciousness, which exhibits predominantly θ (3.5 to 8 Hz) and δ (0.5 to 3.5 Hz) brain waves patterns. These brain waves usually correspond to normally unconscious informational content [11]. At this level, the ionic acupuncture system is partly displaced from the body, and consciousness (i.e., subjective observer) is associated with an electromagnetic component of ELF (Extremely Low Frequencies) brainwaves that are embedded in the low dielectric gaseous weakly ionized medium [12]. The ionic concentration in this diffusionally unstable medium after ~ 1 hour reaches the one in the atmospheric air outside the body, and the ELF brainwaves can flow also through the surrounding weakly ionized atmosphere. The whole system is thus completely open for information exchange within the ELF domain, which can thus bring a sense of oneness with the surrounding world.

Subjectively, this state is experienced as a state of oceanic euphoria, unconditional omnipotence, and pleromatic paradise. Objectively, this level is characterized in our Integrative NLP [1] by deep muscle relaxation, very slow metabolism, and

decreased heart and respiratory rates. This state of awareness can be achieved in Integrative NLP by focusing internally on a body function (i.e. breathing or heart rate), or on simple sensations of light, sound, smell or taste. Prolonged focusing on one external object can also produce this state of consciousness.

4.2 Emotional level

As soon as man identifies with his body, and becomes aware of space, the problem of life vs. death occurs. At this moment appears the existential fear of death. In separating birth from death, man differentiates the past from the future, and becomes aware of historical time. At the Emotional level of awareness man is identified solely with his organism as existing in space (primary dualism) and time (secondary dualism). This knowledge creates an existential need to survive, and the fear of death. This is the level where man's emotional and thought processes, as well as his personal will, first begin to develop.

In developmental psychology, this period has been described as a beginning of the emotional life, and language acquisition. Sensory motor functions are now becoming more complex. The child starts to walk and to talk. He/she becomes more independent from others, and aware of him/her self as a separate emotional/physical being [13]. By 18 months of age, a relatively stable core gender identity (i.e., the sense of being a boy or girl) is established. At the end of the second year, the child begins to use the word "I" when he/she refers to himself or herself. On the biological level, scientists also describe the further development and the myelinization of the Limbic system (Cingulum) responsible for the emotional experience; and Secondary zones of the brain cortex, which are responsible for the further development of perceptual and language functions. The Secondary zones serve as an apparatus for the reception, analysis, and storage of modality specific information arriving from the outside world [10].

The Emotional level includes the second set of filters called *sociogenetic filters*. These filters are the internalized matrix of specific cultural premises, familial relationships, and social glosses; as well as social institutions of language, logic, ethics, and law. The sociogenetic filter represents those aspects of the environment that have been interjected during the developmental process. At the Emotional level, the values of society are becoming mapped into the biological organism that exists in the space and time.

The Emotional level is the level of altered states of consciousness, with predominantly α (8 to 13 Hz) and some θ (3.5 to 8 Hz) brain waves patterns that usually correspond to normally subconscious informational content. At this level, the ionic gaseous structure is still partly displaced from the body, and consciousness is associated with the electromagnetic component of ELF brainwaves embedded in the low dielectric gaseous weekly ionized medium. The difference from the previously described state is that the periods of sleep are significantly reduced.

Subjectively, this state is experienced as a state of pleasant and unpleasant emotions, ranging from bliss and ecstatic release to fear and rage. It is also a state of impersonality, multivalent images, and archetypal forms [14], distance, and dissociation. Objectively, this is the level that is characterized in Integrative NLP by rapid eye movements or eye fixation, middle ear muscle activation, irregular heart rate and respiration, significantly reduced muscle tone with occasional muscle twitches, tremor, or cataplexy and catalepsy. This level can be entered in Integrative NLP by concentrating on different feelings, emotions, and visual images.

4.3 Symbolic level

At the Emotional level, a man fears death and fights for his life. In order to overcome the primordial fear of death, a man creates a permanent image of himself called "ego", which consists of fixed and stable symbols. On this level, man identifies with the seemingly undying idea of himself – his "ego". He becomes aware of himself as "I". His identity shifts from his total psychophysical organism to his mental representation of his organism. This is the tertiary dualism which creates the next major level – the Symbolic level.

On the Symbolic level, a man is not anymore directly identified with his total psychophysical organism as existing in space and time. He now identifies solely with a mental representation or picture of himself. In other words, he is aware of his ego, his self image. He feels that he exists in his body and not as his body. His consciousness is not anymore bound by the emotional level, but shifts to the level of awareness where the intellectual and symbolic processes emerge. His body processes mostly become unconscious, and the symbolic processes start to predominate in his awareness.

In developmental psychology, this period has been described as the beginning of cognitive development – preoperational thinking [15]. From two to seven years of age, the child is capable of forming symbols and concepts, but can not yet operate or coordinate those representations. For example, a child can count objects but cannot easily multiply or divide them. He/she cannot comprehend more than one dimension or property of the object, and cannot understand volume and mass. For example, the child learns to group objects by color or shape, but not both. Also, if the object changes shape, the child does not understand that the object preserves its original mass or volume. The major characteristic of this period is egocentrism because the child is unable to put himself in the place of someone else.

The Symbolic level includes the third set of filters called individual constraints, or *personal filters*. By individual constraints, we refer to all the representations of the world that a man creates during the course of his life, based upon his own unique personal experiences. These models or maps will constitute a set of interests, habits, likes, dislikes, and rules for behavior that are distinctly his

own. Every person has a different set of experiences in life, and thus creates different models or maps of the world that govern his/her behavior.

At the same time, on the brain level, scientists describe the further development and the myelinization of the Tertiary zones of the brain cortex. The Tertiary zones are involved in sensory data integration, and the transition from the level of simple visual representations to the level of complex symbolic processes (e.g. operations with word meanings, with complex grammatical and logical structures and with systems of numbers). The Tertiary zones play an essential role in the conversion of concrete perception into abstract thinking [16].

The Symbolic level is the level with predominantly β (13 to 30 Hz) and α waves (8 to 13 Hz) in the brain. On this level, man is simultaneously aware of normally conscious and subconscious information only in altered states of consciousness related to REM sleep phases, when consciousness is still associated with electromagnetic component of ELF brainwaves embedded in the low dielectric gaseous weakly ionized medium partially displaced from the body [17].

Subjectively, this state is experienced as a state of preoperational or mythic thinking, temporal desires, specific likes and dislikes, tension and relaxation, safety and belongingness. Objectively, this is the level in Integrative NLP where consciousness shifts from the relaxed day-dream state to the normal awake state in which all the activities can be fully performed. On this level in Integrative NLP we apply different techniques that include anchoring or reframing of the specific experience; transforming a negative experience into positive via play or ritual, imaginative problem solving, age regression and metaphorical stories.

4.4 Rational level

Finally, a man identifies with only a fraction of his psychic processes that he considers to be himself. He becomes aware only of the ideal image of himself, and all other unwanted aspects of his ego become unconscious. In an attempt to make his self-image acceptable, he represses all the "bad" aspects of his egoic tendencies, thus creating the new level, called the Rational level. On this Rational level, man imposes a dualism or split upon his own ego, represses the underlying unity of all his egoic tendencies, and projects them as the "persona" vs. "shadow". Such then is a generation of the quaternary dualism.

At the Rational level, man identifies with mostly inaccurate and greatly limited aspects of his ego, his ideal image of himself – his "persona". At the same time, all unacceptable aspects of himself are repressed and are projected as the 'shadow' [14]. Man alienates and dis-identifies with psychic tendencies that he considers to be painful, miserable, or undesirable (e.g., unpleasant thoughts and emotions like fear or rage,

sexual and aggressive instincts, and socially forbidden behavior) and finally projects them into the "shadow".

At the Rational level, man has already lost direct contact with his body, and parts of his ego. Psychoanalytically, the unconscious contains wishes and ideas linked to the wishes that were banished from consciousness via the mechanism of repression. On the Rational level, man dis-identifies himself with other levels that have become completely unconscious. Normal adult man usually spends most of his every day life within the Rational level of consciousness. He is predominantly aware of his ideal self-image in relation to his environment.

In developmental psychology, this level has been described as the level of the concrete and formal operational thinking [15]. At approximately seven years of age, a child starts to comprehend multiple classification, as well as two or more classes occurring simultaneously (e.g. the child can order objects serially along a dimension, such as increasing size from smallest to largest). His thinking is not anymore egocentric and narcissistic. He/she is becoming capable of taking the role of others; and performing rule operations such as multiplication, division, and class inclusion. Concrete operational thinking is still bound to the concrete and obvious world, and cannot grasp possible or hypothetical relationships.

At around eleven years of age, the adolescent attains the capacity for abstract and propositional thinking about multiple variables. He/she is capable of looking at a problem from multiple points of view. The adolescent can analyze each variable independently, or as a part of the whole. Abstract concepts such as truth or virtue are subject to discussion or analysis. Erickson [18] referred to this process as the formation of ego identity. This is the final stage of development of the ego. The mature ego becomes capable of imagining possibilities not given to mere sensory evidence or sensory-concrete operation. On the biological level, there is a continuation of the brain myelinization which occurs on the level of interhemispheric connections that coordinate functions of left and right brain hemispheres.

The Rational level is the level where consciousness, associated with the electromagnetic component of the ELF brainwaves, most of the day-time is dominated by pervasion of the brain's neural network. During this period there is a good separation of normally conscious and subconscious contents in the brain, while mixing of information that belongs to other levels of consciousness is only possible during the REM sleep phases [17]. At this level, the brainwave spectrum of alert state is dominated by the upper two ELF channels: γ (30 to 50 Hz), and β (13 to 30 Hz), and information mostly corresponds to normally conscious content [11].

Subjectively, this state is experienced as a state of concrete and formal operational thinking, inner dialogues, temporal goals and desires, self-esteem needs, self-control and will-power, different emotions (e.g., pride, guilt, love, and hatred). Objectively, this is the level where consciousness is completely associated with the

normal awake state in which all the activities can be fully performed. This is the most superficial level in Integrative NLP [1]. The techniques that belong to this level are: goal planning, time management, future visualization and self-affirmations.

4.5 Creative level

The Creative level is the level where the formal mind integrates all the ideas and experiences into one, whole picture model of the world. Man is now capable of envisioning how the truth or falsity of any one idea would affect the truth or falsity of the others. Man now comprehends a mass network of ideas, how they influence each other, and what their relationships are. This is the Aurobindo's "higher mind" that can make connections, relate truths, coordinate ideas and integrate concepts. It is the highest integrative structure in the individual realm, "self-seen in the integral whole". All the structures of the human psyche are completely integrated into the one whole.

This is the creative phase in the development of human consciousness. There exists no more separation; but rather, integration of the human psyche. The fully integrated rational and symbolic levels are preparing to become one with the emotional level. There is now a completion of brain development, and the final myelinization takes place of all possible inter and intra-hemispheric connections.

The Creative level is the level where consciousness, associated with the electromagnetic component of the ELF brainwaves, together with the ionic acupuncture system, is deliberately displaced from the highly developed neural network of the brain [17,19]. At this level of prolonged altered states of consciousness, there is efficient integration of normally conscious and subconscious contents. The brainwave spectrum is now exhibiting normal brain wave patterns that correspond to γ, β and α waves. In Buddhism this level is called "manovijnana", or the "intellect"; while in Hinduism it is referred as "manomaya" or "linga sarira", the "subtle body".

Subjectively, this state is experienced as a state of self-actualization, vision-logic, high fantasy, synthetic thinking, spontaneity, creativity, and supersensitivity. Objectively, this is the level where consciousness can easily shift from the rational to symbolic level, and finally back to the emotional level of awareness. All the information from these levels can be fully processed and integrated into the Creative level of awareness. The techniques being used in Integrative NLP to enhance the development of the Creative level of awareness are creative modeling, age progression, creative visualization, and moment to moment awareness.

4.6 Supra-Individual level

This is the realm of high religious intuition and literal inspiration, of symbolic visions, of audible illuminations, of blue, gold and white light. This is the realm of higher presences, guides, angelic beings, deities – all of which are high archetypal forms of one's own being [14]. The subject is identified with an object of faith. At its peak, the subject dissolves into the object. The worship, the worshipper and the worshipped are one.

On this level, man transcends his normal capacity of individual mind and body, and returns back to the higher realm of existence. He operates upon the world, and his body and mind, in ways that appear to ordinary people to be fantastic and extraordinary. He develops extrasensory perception, precognition, clairvoyance, psychokinesis, and so on. Man masters the level of psychic phenomena and paranormal powers by fully integrating his rational, symbolic, and emotional level. He originally came from this realm, and can occasionally go back, but the complete integration takes place only after the individual development and synthesis of mind and body. This level appears to be the same as the emotional level of the infant. The difference, though, is that the infant is aware but cannot operate on this level because neither brain nor mind are still fully developed. The infant is the passive observer, while the mystic is the active creator.

This is the level where the ionic gaseous system is deliberately completely displaced from the body. Consciousness associated with the electromagnetic component of ELF brainwaves is now completely embedded in the low dielectric unhomogeneous gaseous weekly ionized medium [17,19]. There is an intense mixing and integration of normally conscious, subconscious, and unconscious information. The brain exhibits a normal spectrum of γ, β, α, θ, and δ waves. Hinduism calls this level "vijnanamaya" or "suksmasarira", the "mental body"; while Buddhism terms this level "manas", and defines it as the persistent source of existential, rational, and volitional awareness.

Subjectively, this state is experienced as a state of rapture, bliss, compassion, and gratefulness, extrasensory perception, developed intuition and inspiration, archetypal forms, audible illumination, and revelations of light and sound. Objectively, this is the level where consciousness can easily process all the information (coming from completely integrated rational-symbolic-emotional levels) in one Supra-individual level. The techniques being used in Integrative NLP to enhance development of this level are lucid dreaming, astral projection, astral travel, hypnotic reincarnation, and personal guides or spiritual teacher visualization.

4.7 Trans-Individual level

The process of integration and transcendence continues even further by dissolving into the higher 'other' realm, leading finally to the Unity itself. This process has been described in both East and West mystical traditions [7,20-25].

At the Supra-individual level, man becomes aware of his archetypal Deity (as ishtadeva, yidam, dyani-Buddha), and finally becomes one with his Archetype. At the Trans-individual level, man-as-deity dissolves into the final-God, which has been described as an intensive subtle 'audible illumination', the ultimate source from which all Archetypal forms emerged. Man becomes one with God. In the final transcendence, all the previous levels become completely integrated, and dissolved into a formless, infinite, unbounded consciousness.

At this level, the displaced ionic gaseous system completely deteriorates, and becomes homogeneous. The ionic concentration in this medium reaches the one in the air, and ELF brainwaves can flow through the surrounding weakly ionized atmosphere. The whole system is now open for information exchange in the ELF domain, which brings the sense of oneness with the surrounding world. At the same time, there is a complete integration of all possible information [17,19]. The brain shows the full range of brainwaves spectrum: γ, β, α, θ and δ waves. In Mahayana Buddhism this level of consciousness is called "alayavijnana", or "supra-individual repository consciousness"; while in Hinduism, they are refer to it as the "anandamaya" or "karanasarira", the "causal body" or "karmic body".

Subjectively, this state is experienced as a state of final illumination, radiant bliss, formless radiance, transcendent love in oneness, formless realization, and boundless consciousness. Objectively, this level is characterized by the final integration of all the levels: rational/symbolic/emotional/perceptual into one Trans-individual level. This state of awareness can be achieved via Integrative NLP by the practice of prayers and meditation [1].

4.8 The Universal level

Man's innermost consciousness is identical to the absolute and ultimate reality of the Universe. On this level, man is identified with the Universal Mind, and his consciousness becomes spaceless and timeless, and therefore eternal and infinite. This is the state of "nirvana", "samadhi", "satori", "enlightenment", state of completely liberated consciousness and peaceful mind. In that moment, there is no distinction between subject and object, self and not self, seer and seen. Therefore, there is no more possibility for sending and receiving any information – man is what there is and all there is.

At this level, there are no differences between the organism and environment. This is the state where a homogenous dielectric medium completely dissolves, enabling the peaceful mind without stream of consciousness [17,19].

Subjectively, the entire world process then arises, moment to moment as one's own Being, outside of which and prior to which, nothing exists. This is the ultimate Unity, where all things and events, while remaining perfectly separate and discrete, are only One. This is the final, undifferentiated state of Universal consciousness; the state of perfect transcendence; which is not a transcendence in the world but a final transcendence as the world itself. By interpreting and integrating all the levels, realms and planes, high or low, sacred or profane, consciousness operates as the entire world process itself. "Form is not other than Void, Void is not other than Form", says the most famous Buddhist Sutra ("The Heart Sutra"; see ref. [22]). At that point, the extraordinary and the ordinary, the supernatural and the mundane, are one and the same. This is the ultimate Unity toward which all evolution, human and cosmic, drives.

The ultimate goal of Integrative NLP is the same as in yoga and related esoteric disciplines – the continual prolongation of altered states of consciousness 24 hours a day, with a displaced ionic system continuously open. This also means that the ultradian rhythm responsible for changes in states of consciousness [26] does not exist any more. The biological basis for this phenomenon is probably the enhancement and completion of all possible connections between the left and right brain hemispheres, which then allows the displacement and complete deterioration of the ionic acupuncture system, accompanied by liberation of the "subjective observer" – i.e. the electromagnetic component of the ELF brainwaves.

5. CONCLUSIONS

It has been shown in the Integrative NLP model of states of consciousness that a conscious brain's neural network is able to process information in any of the following execution modes:

- *Brain*: Processing takes place biochemically in the brain neural networks.
- *Brainwaves*: Processing is parallelly executed biophysically via brainwaves, inside the ionic "optical" neural network of the ionic acupuncture system with embedded electromagnetic field of extremely lowfrequency (ELF) brainwaves. In altered states of consciousness, when a part of the ionic acupuncture system is displaced from the body, the processing is executed outside the body, too.
- *Mixed*: Processing takes place via the mixed modalities of Brain and Brainwaves.

As a result, we have two significant implications: (1) *Superspeed processing* (mixed modal processing in altered states of consciousness exhibits processing speeds that greatly exceed the brain's biochemical rate of execution), and (2) *Proximity leaning* (a conscious brain's neural network is able to impart its knowledge to another close brain's neural network via ELF electromagnetic induction, which is also the basis of healing in NLP hypnotherapy).

Experimental investigation of conscious neural networks is possible, and includes the following procedures:

- Testing, via computer-based tests, of the information processing capacity found in normal and altered states of consciousness;
- Monitoring of the brain activity in normal and altered states of consciousness by using EEG and SQUID brain mapping;
- Detecting the low-dielectric ionic structure by monitoring the local change in the ionic concentration in the vicinity of the body with highly sensitive thermovision image processing;
- Measuring the correlation between information processing capacity and parameters of the theoretically predicted ionic structure (ionic concentration, ionic currents, magnetic fields) in normal and altered state of consciousness.
- Testing of low-power ELF transmission between neural networks with embedded ELF waves: One neural network can transfer its learned information to neighboring neural networks via electromagnetic induction coupling (this might also be the basis for short-range transpersonal interactions, such as healing).

6. SIGNIFICANCE

The advantages afforded to our clients by our Integrative NLP model [1] are as follows:

- Precise and careful documentation and quantification of psychological and biophysical functions in the Integrative NLP diagnostic procedure;
- Appropriate, strategically developed, and carefully considered choice of Integrative NLP therapeutic interventions;
- Flexibility and inventiveness in the selection and application of Integrative NLP therapeutic methods.

The significances of our Integrative NLP model of states of consciousness for the medical and scientific community are as follows:

- This model focuses not only on individual differing deficits and clinical presentations, but also on the client's present abilities, and potential strengths

in normal and altered states of consciousness. The latter are especially important for designing appropriate therapeutic procedures.

- Broad, flexible, effective, and standardized biophysical and psychological diagnostic procedures will enable better understanding of the client's strengths and limitations in different states of consciousness, and facilitate appropriate choice of hypno-therapeutic intervention.
- The careful measurement of the effectiveness of a given Integrative NLP inter-vention, and further monitoring during the course of recovery, will provide useful information to the therapist about possible further intervention. This in turn will allow for the development of more specific Integrative NLP strategies and alternative therapeutic programs.
- The follow-up study of results and outcomes of the applied Integrative NLP inter-ventions can be of great importance for further public health and welfare polices.

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ELECTROENCEPHALOGRAPHIC CORRELATES OF STATES OF CONSCIOUSNESS

EEG studies of drugs acting on the central nervous system
(Ž.Martinović)

EEG and the sleep disorders
(N.Ilanković, A.Ilanković)

Deterministic chaos in EEG signal
(V.Radivojević, M.Rajković, D.Timotijević i M.Car)

On methodology of EEG analysis during altered states of consciousness
(E.Jovanov)

EEG STUDIES OF DRUGS ACTING ON THE CENTRAL NERVOUS SYSTEM

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Abstract. A review of pharmacoelectroencephalography (PEEG) which in a larger sense comprises the study of drug effects upon electrical activity of the brain is presented. The main techniques used in PEEG studies include classical visual EEG analysis, quantified or computerised EEG analysis, nowadays in the form of EEG topography, and the averaging of event-related evoked potentials, in particular contingent negative variation. It is emphasized that these PEEG techniques allow an objective assessment of the effects of neuroactive and psychotropic drugs on the central nervous system (CNS) and have a complementary value. After considering methodological issues regarding both EEG techniques and important pharmacological factors, the relevant data on drug-induced EEG changes are presented. The clinical value of PEEG studies is evident in many respects, such as the classification of the groups of neuroactive and psychotropic drugs, the investigations of dose-response relationships, prediction of therapeutic and toxic drug effects, the diagnostic quantification of the grade and level of brain dysfunction in the coma and substance-induced states of impaired consciousness, the assessment of therapeutic efficacy and the planning of an optimal drug treatment. The sleep-wake patterns in PEEG are considered in relation to various sleep disorders caused by drugs and the influence of drugs on the REM and NREM sleep states. Finally, pharmacological studies of contingent negative variation are dealt with. Further progress in neurophysiological methods may be of great help in evaluating higher cortical functions and drug-induced states of altered consciousness.

Keywords: *pharmacoelectroencephalography (PEEG), neuroactive and psychotropic drugs, drug-induced coma and consciousness disorders, neuropharmacology, REM and NREM sleep, contingent negative variation.*

The study of drug effects on the electroencephalogram (EEG), or in a larger sense upon the electrical activity of the brain is termed pharmacoelectroencephalography (PEEG).

First studies of drugs effects on electrical activity of the brain were done in 1931 by the founder of clinical electroencephalography Hans Berger, who investigated the effects of subcutaneous administration of a dose of cocaine on human EEG [1]. Later, he also noted EEG changes induced by barbiturates, morphine, scopolamine, ethylalcohol, chloroform and amylnitrite. Berger's studies were soon confirmed and extended by Gibbs and Gibbs (1937) [2]. The great impetus for further PEEG studies came from the work of Moruzzi and Magoun (l949) [3] who discovered the role of brainstem reticular formation in EEG and behavioural arousal. Since that time, the application of new techniques, in particular

quantified EEG analysis (known as QPEEG), and the averaging of short latency and event related evoked potentials, in particular contingent negative variation (CNV) [4] provided new electrophysiological measures of the action of drugs upon the central nervous system (CNS). The most recent technical advance applied in PEEG studies is brain electrical activity mapping or EEG topography [5,6], which displays regional features of drug-induced EEG changes in 16-64 channels.

The EEG is primarily concerned with the functional state of the brain and not the cerebral structure. The PEEG allows an objective assessment of neuroactive and psychoactive drugs. For this purpose, two methods of EEG analysis are used: (a) visual analysis which considers several parameters of electrocerebral activity (see Table 1) and (b) automatic or computerised analysis of EEG changes enabling their quantification with various approaches (see Table 2).

Table 1. Main descriptors used in visual EEG analysis

1. Frequency or wavelength
2. Voltage or amplitude
3. Waveform
4. Regularity (frequency, waveform)
5. Manner of occurrence or temporal distribution: random, serial, continuous
6. Location (generalised, lateralized, focal)
7. Reactivity (eye opening, hyperventilation, mental activation, sensory stimulation, movements, etc.)
8. Interhemispheric coherence (homologous areas) a) Symmetry i) voltage ii) frequency b) Synchrony i) wave ii) paroxysm

1. METHODOLOGICAL ISSUES

PEEG methodology is very complex and encompasses both pharmacological and EEG methods. As in other EEG fields, it is practical to distinguish experimental or animal from human or clinical PEEG, since their scopes and feasible methods differ in many important respects [7]. This review describes mainly clinical PEEG studies, while reviews of animal PEEG research are presented elsewhere [7,8].

Table 2. Main methods of computerised EEG analysis

Nonparametric Amplitude distributions Interval or period distributions Correlation functions Power spectral analysis (most frequently used in PEEG)
Parametric Autoregressive models Time-varying signals; Kalman filtering Segmentation analysis
Mimetic techniques used in detection of epileptiform paroxysms
Averaging techniques used in evoked potential studies
Topographic analysis (brain mapping)
Pattern **recognition** (used for analysis of phasic sleep events, CNV, paroxysms)

In general, every PEEG method should include a thorough study and adequate EEG registration before the use of investigated drug. Adequate, age and sex-matched controls receiving placebo should be studied by the same methods and under the conditions identical to those in experimental group subjects. If the alertness or the vigilance is the objective of the study, it should be known that the EEG is the most sensitive of all available methods serving this aim. From the first visual analysis of EEG correlates of vigilance (Loomis et al. 1937) [9], contemporary assessment methods evolved toward the use of much more reliable, standardised quantitative measurements [10]. The EEG of experimental and control group subjects should be recorded during and after the use of drug for a sufficiently long period to give a reliable evidence of the time course of drug-induced EEG changes. Usually, drug-induced EEG changes may be manifested as (1) alterations of previous activities and (2) the appearance of new EEG patterns, not present in predrug EEG. Both types of changes may occur in combination [8]. It should be emphasised that all electrophysiological measures should be studied in relation to the simultaneous observations of behaviour and clinical state of the subjects. When the findings in two groups are compared, they should be described in relation to normative values for a given species, age of subjects, the physiological state, the vigilance level, etc. Statistical analysis is necessary to convert changes from baseline into t - values which are then plotted against frequency.

PEEG is a multidisciplinary field and every student of drug-induced EEG changes has to be aware of a multitude of pharmacokinetic and pharmacodynamic factors (see Table 3) which are of utmost importance for the drug action upon the central nervous system [11]. The individual sensitivity is defined as EEG alterations of drug which are dependent on the type and configuration of the predrug resting records. Beside, the chemical, physiological and psychological states of the

individual are normally susceptible to the phases of infra- and circadian cycles which should be defined in non-drug conditions.

Animal PEEG experiments are usually preceding to clinical testing of the drug-induced central actions. One peculiar type of animal PEEG study deals with the characteristics of drug-induced EEG patterns. In this line of research, neocortical and thalamic spindling induced by barbiturates, hippocampal θ rhythm induced by eserine, and seizure activity induced by systemic or topical application of penicillin, have been used as model for human pathological conditions. Thus, the penicillin models of experimental epilepsy in cat greatly contributed to formulate valuable concepts of epileptogenesis, especially the respective roles of cortical versus reticular seizure mechanisms [12]. The study of barbiturate spindling and of GABAergic thalamic neurons elucidated the role of complex thalamocortical mechanisms responsible for the genesis of rhythmical EEG activities [13].

Table 3. The pharmacological factors of importance in PEEG

The type (chemical structure) of drug
Bioavailability
Route of administration
(topically, to various brain sites; systemically - iv, im, ip, etc.)
Rate of administration, i.e., time-dosage relationship
Permeability of blood-brain barrier
Dosage - therapeutic or toxic; dose-response relationship
Type of exposure - acute or chronic
Receptor sensitivity, Tolerance,
Withdrawal (abrupt or gradual)
Individual sensitivity
Age of individual (effect of maturation in children; effect of ageing, etc.)
Genetic patterns (inherited predisposition and abnormalities, idiosyncrasies, etc.)
Behavioural and psychophysiologic states,
Dietetic measurements
Hormonal and systemic influences
Neurologic, psychiatric and other diseases

Experimental studies allow direct and simultaneous recording of electrical activity of various brain structures, notably neocortex, hippocampus, cerebellum, inferior olivary nucleus, etc. [14]. The simultaneous recording of electrical activity from these structures provides a better understanding of complex cerebral electrophysiology. This is evident in the finding that the same behavioural state is associated with different types of electrical activity in various cerebral areas. Thus, the state of arousal correlates with the fast frequency low voltage record (desynchronization) in neocortex and with hippocampal θ rhythm. The types of drug-induced EEG changes may be similar in one brain area and quite different in another structure. In experimental studies, drugs which have quite different chemical

structure, such as strychnine and barbiturates, have dissimilar effects on neocortical electrical activity but induce fairly similar rhythms in electrocerebellogram [7]. The complexity of central drug actions should be taken into account in clinical studies when it is customary to record the EEG activity from superficial potential field at the scalp. Therefore, one of the greatest limitation of PEEG methods is that the data it provides are not suitable to determine the sites of drug actions on the brain. At best, in experimental studies, it can reflect the functional state of the brain at various integrative levels. This requires the combination of EEG recordings with other experimental methods, such as brain transections at various levels, electrocoagulation of discrete brain areas, the use of neuroimaging in the form of magnetic resonance, positron emission tomography, etc.

The use of drug-drug combination may be of value in studying how the manipulation of neurotransmitter systems influences the functional state of the brain [7,8]. This is exemplified in the use of one agonist (diazepam) and its antagonist (flumazenil) which acts on GABA receptor sites. The method is useful in clinical PEEG research. A similar approach is the use of drug - nutritive compound combination, such as the use of L-tryptophan and vitamin B6 in contingent negative variation (CNV) studies [15]. It was found that repletion of vitamin B6 increases CNV amplitudes. On the other side, CNV reduction that normally occurs with L-tryptophan disappears during vitamin B6 depletion. These findings suggested the role of serotoninergic systems in the regulation of electrophysiological parameters.

The PEEG in clinical investigations is used for multiple practical aims: (1) the classification of neuroactive and psychotropic drugs, (2) the study of dose - response relationships, (3) the prediction of therapeutic and toxic effects, (4) the quantification of the grade and level of brain dysfunction in states of impaired consciousness, (5) the determination of diagnosis and outcome of coma caused by the drug intoxication, (6) help in planning an optimal treatment and in the assessment of its efficacy, (7) correlating the treatment outcome with EEG findings. Obviously, clinical PEEG studies are plagued with methodological problems which are more difficult to solve than in experimental PEEG research.

The EEG of non-drug condition or spontaneous EEG is largely unknown in the cases of acute drug intoxication. Beside, the intoxications are often caused by multiple drug exposures. The use of drugs in controls is limited by ethical problems so that only single doses or short-term use of non-toxic drugs in adult healthy volunteers may be allowed for PEEG studies. The findings in various subjects are comparable only if predrug spontaneous EEG is of the same type, because the same dose of a single drug can induce alterations that vary with different types of EEGs. Itil (1982) [16] has found that neuroleptic drug thiothixene in a dose of 40 mg a day, but not the placebo, induced prominent α rhythms in an EEG with predominant low voltage β activity. On the contrary, the same dose induced only slight changes in an EEG already containing prominent α activity or in an EEG showing slow frequency

activity. The EEG in all three types of predrug EEG was identical, namely increased slow activity when a higher dose (64 mg a day) was applied.

The effects of certain drugs (barbiturates) on EEG are dose-dependent in such a way that one type of changes (fast diffuse activity) is induced with therapeutic doses and another type (abnormal slowing) with intoxicating drug levels. Drug-induced EEG changes may have different location in patients with structural brain abnormalities than in those without such type of neuropathology. Thus, fast EEG activity inducible by barbiturates or benzodiazepine drugs is less abundant over the cerebral hemisphere or over one of its area with structural pathology (i.e., atrophy, tumour, etc.) [17,18]. Slowing of EEG activity produced by drugs often becomes evident only if the patient has depressed consciousness or other signs of toxicity. The interpretation of PEEG findings necessitates their correlation with clinical state, level of vigilance and pharmacological factors. The EEG changes in clinical setting are reliably related to drug effects only when other causes of EEG alterations can be reasonably excluded. Furthermore, any of drug-induced EEG changes may be due to: (a) direct drug effect on the brain area selected for recording, (b) drug action on a distant brain region projecting on the area selected for recording, and (c) the action of drug on peripheral systems (respiration, circulation, etc.) with a secondary EEG effect that is frequently seen in the case of severe drug intoxication.

2. THE EFFECTS OF MAIN DRUG CLASSES ON THE EEG

Many studies attempted to define the types of EEG changes which might characterise one particular drug or one class of drugs. Visual EEG analysis discerns only slight EEG alterations after the use of therapeutic doses of psychotropic drugs. Therefore, it must be supplemented with QPEEG methods, such as spectral analysis. This approach [8] gave positive results which are summarised in Table 4. The sedative neuroleptics such as chlorprothixene augmented EEG synchrony and increased θ-δ power. These features enabled their distinction from non-sedative neuroleptics such as haloperidol which decreased α power and increased β activities. Marked increase of very fast (β_2) activity is a common feature of anxyolitics and hypnotics, drugs which share sedative properties. The best investigated of all nootropic drugs, pyritine increases both α and β power. This effect is associated with improved vigilance. The psychotogenic substances of LSD type produce EEG alterations which are different from those induced by marihuana. This adds further evidence that their mechanisms of action are different. The acute effect of marihuana and its active principle, δ-9-tetrahydrocannabinol (THC) have recently been studied with brain mapping technique [19]. It was found that heavy marihuana users in comparison to placebo showed increased absolute and relative power of all frequencies over all cortical areas. The elevated relative and absolute power and coherence of α activity is maximal in frontal region. This hyperfrontality

of response is in accordance with the studies of THC uptake in squirrel monkey where highest concentrations are reached in the frontal cortex [20]. The type of α activity elevation with THC is not known to occur with other psychotropic medication.

Table 4. The effects of psychotropic agents on the EEG

Drug class	**Synchronisation**	**Theta (θ) - delta (δ)**	**Alpha (α) 8-13 Hz**	**Beta 1 (β_1) 13-20 Hz**	**Beta 2 (β_2) >20 Hz**
Neuroleptics					
Sedative	+	+ +	- -	-	+
Nonsedative	0	0	-	+ +	+
Antidepressants	-	+	-	0	+
Anxiolytics	-	0	-	+ +	+ +
Hypnotics	+	+ +	- -	+ +	+ +
Nootropics	0	-	+	+	+
Psychotogenics					
LSD	-	-	+	+	+
Marihuana	0	0	+	0	0
Amphetamine	-	-	-	+	+

Key: 0, no effect or not typical; +, increase; ++ strong increase; - decrease; - - strong decrease (Modified from A.Wauquier, EEG and Neuropharmacology, in E.Niedermeyer and F.Lopes da Silva, eds. *Electroencephalography...*- see ref. [23], p. 623)

Drugs of abuse cause a variety of EEG alterations which are summarised in Table 5. A single dose of morphine usually has minimal EEG effects. However, intravenous administration of heroine has caused EEG changes evolving from increased α voltage and decreased α frequency toward a decreased amount of α rhythm associated with increased θ-δ activity [21]. Epileptiform activity was sometimes produced and the occurrence of seizures was exceptional. Naloxone, morphine antagonist, reversed these effects.

Hallucinogenic drugs, such as LSD, mescaline, psilocybin produce desynchronised β activity with a decreased amount of other frequencies. Phencyclidine causes an augmented amplitude of β activity and in the case of acute intoxication a non-reactive diffuse θ activity is associated with pseudoperiodic bursts of δ waves.

Many EEG studies considered acute toxicity of ethylalcohol and various aspects of alcoholism. The acute effects of alcohol usually include a slowing of α rhythm which is minimal (0.3-1.0 Hz) at alcohol level below 0.1%, but becomes considerable with higher level and reaches 3 Hz at level of 0.2% [22]. EEG recovery from the effects of alcohol takes a longer time course than clearing of alcohol after

the ingestion has stopped. Individual susceptibility to the toxic effects of alcohol may be increased in several populations, such as subjects with abnormal EEG, a history of craniocerebral trauma, or a history of epilepsy.

Table 5. Drugs of abuse and their EEG effects

Drugs	Single or repeated use	Intoxication
Opioid analgesics Morphine Heroin Methadone Codeine	Single use: minimal change. Repeated doses: slowing of α rhythm which may return to normal with tolerance.	Diffuse slowing with θ and δ increase and decrease in α rhythm.
Meperidine HCl	Slowing of the background activity and increase in θ and δ activity.	α coma pattern with morphine overdose.
Psychostimulants d-Amphetamine Methylphenidate Caffeine Nicotine	Increased power of α and β activity. Little or no change seen with visual analysis.	Diffuse θ-δ slowing. Cocaine even in low doses may provoke convulsions.
Hallucinogens LSD Marihuana Psilocybin	Occasionally augmented β activity; mostly little or no changes. Increased voltage of β activity.	Rhythmic θ activity and periodic slow complexes. Increased θ waves.
Ethylalcohol	In chronic alcoholism decreased voltage of background activity. Marked slowing in Wernicke's encephalopathy.	During acute intoxication with high blood levels: diffuse θ-δ activity.

EEG of chronic alcoholics show further slowing down and decreased amplitude of background activity. These mild EEG changes are frequent in patients without neuropsychiatric complications of alcoholism. A marked slowing down of background rhythm with increase in θ and δ activity occurs in patients with Wernicke's encephalopathy.

Acute intoxication with any type of neuroactive drugs causes various grades of impaired consciousness progressing to coma. Nowadays, drug poisoning has become the most frequent single cause of non-traumatic coma. Neuroactive drugs impair cellular metabolism in various ways, including complex biochemical processes. The consequent disorders of brain functions are at first reversible, but at a later stage brain hypoxia leads to permanent structural lesions. In this stage, the prognosis of drug-induced coma becomes ominous.

The EEG findings are not reliable prognostic factors at early stage of drug poisoning when clinical signs have the primacy in measuring the outcome. However, in later phases EEG stages of coma have great prognostic significance [23]. One type

of EEG findings suggestive of drug intoxication is an abundant diffuse fast activity caused by barbiturates, benzodiazepine and other hypnotics (glutethumid) or sedative drugs (see Table 6). The EEG effect appears even in small doses. The fast activity induced by barbiturates is in the range of 25-35 Hz soon shifting to 15-25 Hz. It is first apparent over the frontal cortex and spreads to parietal and occipital areas. Benzodiazepine-induced fast activity is very similar, but has a slower frequency range (14-25 Hz). It may persist in the EEG as long as two weeks after the last drug intake.

Higher and toxic doses of barbiturates produce the dissolution of α rhythm which is associated with drowsiness and sleep. Further diffuse slowing to θ and δ frequencies and disappearance of fast activities accompanies the stages of stupor and coma. If not treated, barbiturate-induced coma progresses to metabolic disturbances and triphasic waves in EEG. There follows brainstem dysfunction associated with burst-suppression pattern in EEG. The recovery without sequellae was described even when the coma caused by drug poisoning progressed to an isoelectric EEG (electrocerebral inactivity) [14].

Lithium is used as an antimanic agent in long-term therapy. Serious toxic effects correlate well with plasma concentrations. Obtundation, stupor or delirium appear when the plasma level reaches above 2 mEq/litre. EEG changes are marked and diffuse, including various degrees of slowing and epileptiform paroxysms. Triphasic waves and burst suppression are apparent in comatose patients.

Alpha coma pattern is more frequently due to cardiorespiratory arrest and brainstem stroke but may be caused by sedative drugs (see Table 6). Unreactive α coma pattern caused by drugs tends to have a higher voltage of α frequency (50-150 μV), a spindle-like morphology, admixture of slower waveforms and very slow activity (1 Hz), and a frontal or fronto-central amplitude maximum. On the other hand, hypoxic-ischemic α coma pattern is of lower amplitude (usually below 50 μV), rather diffuse and monotonous, unassociated with slower frequencies [24]. However, a considerable overlapping of these features between the two groups shows that their value in differentiating the etiology of coma is relative.

The spindle coma pattern is the term for unreactive EEG in coma containing spindles and other phasic event of NREM sleep. It is only exceptionally due to drug intoxication.

A large number of drugs potentiate or elicit epileptiform paroxysms. Convulsant drugs such as strychnine are applied only to animals in experimental research. Megimide and pentylentetrazole were used as EEG activating agents in clinical setting before the advance of long-term video EEG monitoring. Many important medicaments reportedly provoked EEG paroxysms and seizures (see Table 7). Psychotropic drugs in this regard may be divided in three groups: a marked potentiation of epileptiform discharges is caused by chlorpromazine and lithium; thioxanthene, butirophenones and amitryptiline are moderately potentiating;

imipramine, MAO inhibitors, thioridazine, meprobomate and methylphenidate have slight or no potentiating tendency [25].

Table 6. EEG findings in coma due to drug poisoning

EEG findings	**EEG Causative substances**
Abundant diffuse fast activity	Benzodiazepine derivatives, Barbiturates, Glutethimide
Generalised slowing without induced fast activity	Phenothiazines, phenytoin, carbamazepine
Diffuse slowing, sharp waves, triphasic waves and rarely periodic complexes	Lithium
Epileptiform paroxysms	Lithium, antidepressants, sometimes phenotiazines
α coma pattern	Tricyclic antidepressants chlormethiazol, nitrazepam
Spindle coma pattern	Ethanol, imipramine

Inhalation of anaesthetic enflurane may induce various types of epileptiform discharges and seizures depending on its concentration. These effects may occur in patients with epilepsy and even in normal subjects without a history of seizures.

Several drugs (barbiturates, alcohol) provoke EEG discharges and seizures after an abrupt cessation. These withdrawal seizures usually occur in the first 48 hours after stopping drug intake and are more frequent in patients showing photoparoxysmal response.

Antiepileptic drugs share a common property to suppress or abolish epileptiform discharges and seizures (see Table 7).

Anticonvulsant benzodiazepines (diazepam and clonazepam applied intravenously, and midazolam, intramuscularly) promptly abolish primary generalised discharges but are less effective against focal paroxysms. Secondarily generalised paroxysms are partially suppressed with these drugs and their focal or multifocal origin becomes evident [26]. Carbamazepine is effective against partial seizures but does not suppress interictal paroxysms.

Main antiepileptic drugs usually cause slight slowing down of background activity and marked slowing down appears only in cases of intoxication (see Table 8). Augmentation of epileptiform discharges may occur with toxic doses of phenytoin.

Table 7. The effects of drugs on epileptiform paroxysms

Induction (activation)	During acute and chronic use: Aminophyline, Antidepressants, Anticholinergics, Antihistamines, Baclofen, Cocaine, Chloramphenicol, Chloroquine, Disulfiram, Fenfluramin, Enflurane, Insulin, Isoniazid, Lithium, Local anaesthetics (intravenously), Neuroleptics, Opioid analgetics, Penicillamin, Penicillin, Radiographic contrast medium given intrathecally, Sympathomimetics, Theophylin During abrupt withdrawal: Anticonvulsants, Sedatives, Hypnotics In toxic dosage: Anticonvulsants
Suppression	with acute intravenous use: Acetazolamide, Clonazepam, Diazepam, Lorazepam, Midazolam, Phenytoin, Valproates with chronic use: Clobazam*, Clonazepam*, Ethosuximide, Lamotrigine, Phenytoin, Valproates

* Lack of anticonvulsant effect may occur due to tolerance development.

Table 8. The effect of main antiepileptic drugs on EEG

Drug	**Therapeutic doses**	**Intoxication**
Carbamazepine	Slowing of α rhythm and increase in θ activity	Generalised θ-δ slowing
Ethosuximide	Insignificant effect	Reduced α rhythm and generalised θ-activity
Phenytoin	Slowing of α rhythm and increased θ activity	Slowing of α rhythm and generalised δ-activity
Valproates	Occasionally slight increase of θ activity	Generalised θ-δ activity

A majority of general anaesthetics show a good correlation of EEG changes and grades of anaesthesia which represents a medically controlled model for intoxication with most CNS depressant drugs. In general, an initial fast activity is associated with the dissolution of α rhythm. During excitation phase, paroxysmal activity may become prominent, especially with use of enflurane. The EEG activity becomes slower with deeper stages of anaesthesia. Later, burst-suppression pattern may appear; it indicates the involvement of brainstem functions. EEG is important method in monitoring the anaesthesia, but the use of multiple drugs for induction and/or for maintenance of anaesthesia makes the assessment very complicated [27]. EEG is better suited to reveal the eventual central complications of anaesthesia and for monitoring the recovery from anaesthesia [28]. A favourable recovery is as a rule

associated with the return of normal rhythmic activity of waking state and symmetrical phasic events of sleep.

3. ANALYSIS OF SLEEP-WAKE PATTERNS IN PEEG

Various types of sleep disorders may be caused by drugs (see Table 9) and many drugs affect two states of sleep, i.e., REM and NREM stages 1-4 (see Table 10). Polysomnographic studies have shown that REM sleep is much more sensitive than NREM sleep to the central actions of drugs. After stopping the ingestion of drugs that suppress REM sleep, there follows a REM sleep rebound associated with vivid dreams.

Central sedative effects are not caused only by hypnotics and drugs targeted for CNS. Thus, transitional antihistamines increase slow wave sleep and decrease REM sleep duration. Sleep EEG patterns can also be affected by drugs. Benzodiazepine derivatives enhance both the amount of K-complexes and spindles. Other drugs may cause dissociation of behavioural sleep with EEG patterns, such as seen with scopolamine and some anaesthetic agents (halothane).

These findings prove that the assessment of drug effects on sleep and sleep-wake patterns is very complex.

Table 9. Sleep disorders caused by drugs

Category of sleep disorder	**Drug class and individual drugs**
Disorders of sleep initiation and maintenance - *insomnia*	CNS stimulants (amphetamine, and methylphenidate); chronic abuse of caffeine and nicotine; withdrawal of sedatives, hypnotics and sleep potentiating drugs: cocaine, marihuana, opioid analgetics, phencyclidine, etc. Antimetabolites and other anticancer agents, Antiviral agents, ACTH and corticosteroids, Antiparkinsonian drugs, α methyldopa, Atropine, Oral contraceptives, Propranolol, Reserpine, Thyreosuppressive drugs
Excessive daily somnolence *hypersomnia*	Hypnotics, Sedatives, Tranquilizers Development of tolerance to CNS stimulants (Amphetamine, methylphenidate, etc.)
Behavioural events during sleep - *parasomnia*	Withdrawal of drugs that reduce the duration of REM sleep may cause confusional states at awakening in elderly

Table 10. The effects of drugs on REM and NREM sleep

Drugs	Dosage	Main effects on sleep
Barbiturates		
Amobarbitone	200 mg	D. REM; I. REM latency
Pentobarbitone	100 mg	D. REM; I. REM latency
Phenobarbitone	100 mg	D. REM
Ethanol		
(brandy or	100 g	D.REM sleep in first 1/2 of sleep
whiskey)	200 g	D. REM sleep during whole night
Benzodiazepines		
Chlordiazepoxide	50 mg	D. Stage 4
Diazepam	10 mg	D. Stage 4
Diazepam	15 mg	D. REM sleep; D stages 2 and 4
Flurazepam	30 mg	D. Stages 3 and 4
Lorazepam	2 mg	D. REM sleep
Diphenylhydramine	50-100 mg	D. REM sleep
Glutethimide	0,5-1,0 g	D. REM sleep
Meprobomate	0,4-0,8 g	without significant effect
L-tryptophan	1-10 g	Normal sleep organisation
L-tryptophan	> 10 g	D. REM sleep

D. = decreased; **I**. = increased

4. PEEG STUDIES OF CONTINGENT NEGATIVE VARIATION (CNV)

CNV consists of slow surface negativity that depends upon the association or contingency of two successive stimuli [29]. It was shown that CNV is a useful measure of brain-behaviour functions, particularly psychological processes. It is best correlated with psychophysiological state of organism, in particular with the attention-arousal levels. These processes may be seen as a necessary precondition for task solving - or cognitive activity.

The main results of drugs modifying CNV in terms of increase or decrease are summarised in Table 11. A decrease of CNV appears not only with drugs that induce marked EEG changes (barbiturates, benzodiazepines, etc.) but also with those without such effect (morphine, THC, etc.). Therefore, the conventional EEG and CNV studies appear to be complementary PEEG methods.

The PEEG studies lead to a neurochemical model of CNV. The main role was ascribed to dopamine since dopamine agonists, such as amphetamine and apomorphine increased CNV, while dopamine antagonists, such as chlorpromazine and metoclopramide have decreased CNV. Although the role of dopamine appears crucial, other neurotransmitters, especially serotoninergic system may be involved in the mediation of CNV.

Table 11. Main effects of drugs on CNV

Decreased CNV
Sedatives and hypnotics (Benzodiazepines, such as flurazepam, midazolam, nitrazepam etc.; Phenobarbiton) Chlorpromazine δ-9-tetrahydrocannabinol, morphine Nitrous oxide, ethylalcohol, Vitamin B6 depletion, Experimental exposure to carbon monoxide
Increased CNV
Psychostimulants (d-amphetamine, methylphenidate*, caffeine*, nicotine*) Growth hormone, thyroxin Repletion of vitamin B6 probably due to dopamine agonism

* Not confirmed in all studies; results vary with the subject types - see Table 12. Amphetamine use in children with attention deficit disorder produces CNV normalisation.

The effects of a given drug on CNV are different in various subjects depending on their psychological processes. In general, two types of subjects among normal volunteers are distinguished: type A is associated with a high level of uncertainty and type B with a high level of certainty. There is a higher incidence of type A than type B in neurotic group, and the reverse is true for psychotic group. The amplitude of CNV is lower and reaction time slower in type A than in type B. Type A is associated with auditory stimuli, type B with visual stimuli [29]. The A-B typology correlates well with very complex psychological capabilities such as time estimation and has proven great empirical validity in studies of the drug-induced CNV changes (see Table 12).

The state of the organism at the time of drug administration is also important in CNV studies. Munte et al (1984) [30] have found that the effect of caffeine is different in emotionally stable and emotionally labile individuals: an increase occurs in stable subjects (with low arousal) while a decrease is evident in labile subjects (with high arousal). Further progress in CNV methodology may help to evaluate psychological functions that underlie normal and abnormal brain processes and to define some relations of drugs with altered states of consciousness. The averaging of CNV trials in an "attend" and an "ignore" paradigm is to be encouraged in future work, in order to optimise the measurement of the attention component. The development of magnetoencephalography [31] and its application in CNV research may help to define the source location of event related potentials.

Table 12. CNV drug studies using type A and Type B groups

Drug	**Subjects**	**Effects**
Dextroamphetamine 10 mg	20 volunteers	A. excitation and CNV **I** B. paradoxical drowsiness and CNV **D** 2nd & 3rd hr
Methylphenidate 10 mg	30 elderly	A. CNV no change B. CNV **D** 1st hr
Phenobarbiton 100 mg	30 volunteers	A. Sustained attention **0** B. Sustained attention **D** 3rd hr; dysphoria **I** 3rd hr
Methadone 40-65 mg	12 drug-dependent	B. faster RT than A (2nd &3rd hrs); B. better patients sustained attention than A. (1st hr)
Mesoridazine 50-400 mg/day or Thioridazine 0,1-0,8 g/day	12 chronic schizophrenics	B. higher CNV than A.
Dextroamphetamine 15 mg	16 volunteers	A. CNV **0** B. CNV **I** 1st, 2nd &3rd hr

* A: type A group; B: type B group; **D:** decrease; **I:** increase; **0:** no change; RT: reaction time. Modified from J.J.Teece and L.Cattanach, Contingent negative variation (CNV), in E. Niedermeyer and F. Lopes da Silva, eds. *Electroencephalography*... see ref. [23].

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EEG AND THE SLEEP DISORDERS

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Abstract. Sleep is a regular, recurrent, easily reversible state of the organism that is characterized by relative quiescence and by a great increase in the threshold of response to external stimuli relative to the waking state. The most important questions in sleep research are: Why sleep? What are the functions of sleep? We hypothesized two most important functions of sleep: (1) the physiological function of sleep as an adaptive behavior is "saving the brain from critical cooling", and (2) the psychological function of sleep is "keeping the continuity of mental functions/psychic life through the "dream process" (Ilankovic N.,1989). Scientific sleep research began little more than 120 years ago and may be divided into two eras: (1) Pre-EEG era, the period from about 1860 to 1935; (2) EEG era, the period from 1935 to the present. The EEG era in sleep research may be said to have begun in 1935 when Loomis, Harvey, and Hobart made the first classification of the electrical activity of the human brain during sleep. Aserinsky and Kleitman investigated the rapid eye movement (REM) sleep state and its relation to dream reports. The discovery of the human electroencephalogram (EEG), followed by the technology to study the electrophysiology of sleep, has made possible objective measurements of patients suffering from sleep disorders. There are four major categories of sleep disorders: (1) Disorders of Initiating and Maintaining Sleep (DIMS); (2) Disorders of Excessive Somnolence (DOES); (3) Disorders of the Sleep-Wake Schedule; and (4) Parasomnias. The advent and development of computer technology has made the storage and the analysis of EEG sleep data quicker, less complicated and less expensive. The electroencephalogram (EEG), electrooculogram (EOG) and electromyogram (EMG) are the basic measurements commonly performed in all sleep laboratories (EEG + EOG + EMG = PSG, *Polysomnography*). More recently developed ambulatory monitoring systems allow for the recording of data on a tape recorder directly attached to the patient/subject - *Cassette Polysomnography*. ACPSG has begun to uncover the structure and dynamic of disturbed sleep, and the relationship between sleep and various medical disorders. The *model of exogenous perturbation of sleep* is the characteristic of exogenous/reactive (depressive) states - the increased Number of Nocturnal Awakenings (NAW) is statistically the most important phenomenon. The *model of endogenous perturbation of sleep*, found in endogenic depression (mania, OMD, schizophrenia, paranoid states, anorexia, alcoholism) is composed of the following parameters of nocturnal sleep: (1) Shortened REM-latency, (2) Reduction of "delta sleep", (3) Increased Index of Endogenous Perturbation (IEP), and (4) Prolonged REM-1 phase (SOREMP). The results of our investigations demonstrate that the index of endogenous perturbation (IEP-P1 = REM-1/NREM-1) is a highly reliable indicator of the development/regression of *endogenic perturbation of sleep* in depression, mania, schizophrenia and other psychotic states (altered states of consciousness), organic brain syndromes, etc.

Keywords: *EEG (electroencephalography), PSG (polysomnography), sleep, sleep disorders.*

1. THE SLEEP PROCESS

Sleep is regular, recurrent, easily reversible state of the organism that is characterized by relative quiescence and by a great increase in the threshold of response to external stimuli relative to the waking state [1].

The most important question in sleep research is: Why sleep? What are the functions of sleep? Some researchers have even implied that sleep is a "vermiform appendix" that may have once served the function of keeping ancestors out of harm's way for a portion of the day but has no remaining function now. Most researchers believe that sleep is - adaptive behavior (adaptation on day/night, light/darkness natural rhythm; or bioenergetic/thermoenergetic process which saves the energy; or that sleep does serve some restorative function...

In our point of view, we hypothesized two most important functions of sleep: (1) the physiological function of sleep as an adaptive behavior is "saving the brain from critical cooling" (Ilankovic N, 1986), and (2) the psychological function of sleep is "keeping the continuity of mental functions/psychic life through the "dream process" (Ilankovic N, 1989) [2].

1.1 The neurophysiology of sleep

The waking state depends on the activity of the ascending reticular activating system (ARAS), which sends impulses to the forebrain for maintenance and physiological fluctuation of cortical activity ("cortical tonus") as a basis for all cognitive functions. For some time after discovery of the ARAS (Moruzzi & Magoun, 1949, cf. ref. [3]) it was assumed that sleep supervenes whenever ARAS activity falls below a certain level ("the passive theory of sleep"). The synchronized, "slow sleep" (NREM sleep) in animals probably depends on the activity of certain "centers" in brain stem - especially the raphe nuclei (Moruzzi l962, Jouvet, 1962, 1966, cf. ref. [3]) and certain areas in the medial forebrain ("the active theory of sleep"); other areas in the hypothalamus and the thalamus cannot be excluded. On the other hand, a brain stem system is necessary for the initiating and maintenance of paradoxical "fast sleep" - REM (Rapid Eye Movement Sleep). A region in the lower brain stem containing giant cells - the frontal gigantocellular field (FTG) may play a direct role in initiating REM sleep. McCarley and Hobson (1975) proposed (cf. ref. [3]) that the states of sleep are regulated by a process of reciprocal inhibition between those FTG cells and the locus coeruleus. It seems likely that a reciprocal relationship involves the raphe nuclei and other areas in the addition to the relation between the FTG cells and the locus coeruleus (Hartmann, cf. ref. [1]).

Within that broad area, specific monoamine-containing pathways seem to be implicated in arousal or waking. The serotonin-containing raphe system is definitely necessary for normal sleep of both kinds (NREM, REM) to occur. The ascending

noradrenergic system originating from the locus coeruleus and other brain stem norepinephrine regions play an inhibitory role in REM sleep (Hartmann, 1973) [1].

1.2 Sleep and dream

Many psychological and psychophysiological studies indicates that the both electrophysiological types of sleep are identifiable as different in mental activity.

The mental activity in NREM sleep is generally less vivid, less visual, less well recalled, more conceptual, more plausible, less bizarre, more like thinking than dreaming, less emotional, more concerned with contemporary waking experience and under greater volitional control.

On the other hand, the mental activity in REM sleep - dreaming, has the opposite characteristic. The dreams have other language, different symbolism with individual and collective meaning, altered dimensions of time and space (similar to the altered state of consciousness).

Freud's observation that state of sleep makes the formation of dreams possible by a reduction of the power of the censorship ("the way to unconscious..."), may have a neurophysiological analogy in the activation of REM through the activation of rhombencephalic and associated limbic circuits in relation to the reduction of controlling influences flowing from the corticofugal inhibitory systems.

Freud (1933) also viewed the dream process as a regressive mental functioning in the sleep state (cf. ref. [4]). The regressive form of mental functioning in the dream process can be connected to the rhombencephalic pattern of sleep that is both ontogenetically and phylogenetically the more primitive form of sleep activity: Jouvet (1966) referred to such REM activation as "archisleep" (cf. ref. [1]).

Modern neurophysiological research has opened up new vistas in the understanding of the mechanisms of the dreaming process. Two basic and conflicting hypotheses remain: (1) Freud's basically psychological hypothesis of diminished endopsychic censorship; and (2) Psychophysiological hypothesis of spontaneous activation of neuronal circuits as the underlying cause of dreaming activity. In our hypothesis (Ilankovic N., 1986) the REM sleep (as one dimension of a very complex dreaming process) has the underlying mechanisms in electromagnetic phenomena through the sleep [2].

The explanations of functions of dreaming activity are hypothetical, too. Some scientists said: all is in Freud's works; others (psychophysiologists): in "dream activity" the important process is the work up of visual information, selection and memorizing some of them. The hypothesis about "cleaning" function and tendency to "equipotentiallity" of information through dreaming, is the very current theory today [4].

2. THE SLEEP DISORDERS

Sleep disorders are major psychiatric disorders that affect up to 30 percent of the population. In many sleep disorders a careful diagnostic workup reveals a specific cause of the insomnia and a specific treatment aimed at the cause may be used.

There are two major categories of sleep disorders in the revised third edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R) [5]:

(1) The *dissomnias*,

(2) The *parasomnias*.

The *dissomnias* are:

(a) Insomnia (difficulty in falling asleep),

(b) Hypersomnia (excessive amounts of sleep or complaints about excessive daytime somnolence),

(c) Sleep-Wake schedule disorder.

The *parasomnias* are a heterogeneous group of disorder in which episodic nocturnal events occur during the sleep or at threshold between wakefulness and sleep.

Very similar is the diagnostic classification of the Association of Sleep Disorders Centers (ASDC) with about 80 sleep disorders in 4 diagnostic groups [6]:

(1) Disorders of Initiating and Maintaining Sleep (DIMS),

(2) Disorders of Excessive Somnolence (DOES),

(3) Disorders of the Sleep-Wake Schedule,

(4) Parasomnias.

3. ELECTROENCEPHALOGRAPHY (EEG) OF HUMAN SLEEP - A HISTORY

Scientific sleep research began little more than 120 years ago and may be divided into two eras:

1. Pre-EEG era, the period from about 1860 to 1935,

2. EEG era, the period from 1935 to the present.

3.1 Pre-EEG era

Prior to the development of EEG researchers employed a variety of measures to describe human sleep. These included: threshold determinations, physiological measures such as body temperature, heart rate, respiration, pupillary size, metabolic rate, galvanic skin response (GSR) and electromyogram (EMG). In addition, monitoring of body movement was an extensively used technique.

Wohlish (1957) documented the beginning of scientific inquiry into sleep (cf. ref. [3]) in his account of the thresholds experiments of Kohlschuter in 1860. Wohlish also described Fechner's account of what may be the first attempts to measure sleep "whereby the strength of sound necessary to awaken a sleeping person can be used for the measurement of the depths of sleep" (Fechner, 1860). Over the years many attempts have been made to measure and describe the depth of sleep in relationship to the strength and subjective relevance of various stimuli required to produce arousal.

Body movement during the sleep was also extensively measured prior to the period of EEG, but one of the most commonly used indices was a sleep duration. In the midst of these widespread efforts to peer into to dark world of the sleeping subject came the interesting but seemingly irrelevant news in 1875 that Caton had detected currents from electrodes placed on the skull or the exposed brains of rabbits and monkeys (cf. ref. [3]).

However, it is cause for some wonder that no one was interested in the work of Hans Berger some fifty years later, when in 1924 he recorded the first human EEG from electrodes on the scalp! Sleep researchers of the day paid no attention whatsoever, and when Berger undaunted, published his work in 1929, the scientific community in general greeted the news with incredulity (cf. ref. [3]). It is interesting to note that Berger was not the only one whose EEG findings were not accepted. A medical student at Harvard Donald McPherson in 1918, noted regular 10 per second waves recorded from electrodes placed on an exposed cat brain. However, when his superior criticized his findings as artifact, he pursued the discovery no further and the tracing was not found until 1944 when the laboratory was being cleaned of old materials (cf. ref. [3])! Gibbs and Gibbs (1951) suggest that Berger's work unheralded because he was a psychiatrist and published his work in psychiatric journals under titles that were "not especially informative"; and that if Berger had "divided his work into discrete short studies, with satisfactory descriptive titles, and had avoided the psychiatric implications of his data, he might have been accepted more readily as a great neurophysiologist ..." (cf. ref. [3]). Herbert Jasper (1969) comments: "... It seemed highly unlikely at that time that the simple rhythmic waves, the "Alpha und Beta Wellen" of Hans Berger could possibly represent the true electrical activity of such complex nerve tissue as the cerebral cortex especially in man, recorded not by experienced electrophysiologists but by a *psychiatrist* with rather

crude and simple apparatus ..." (cf. ref. [3]). Whatever the reason, Berger's work did not receive recognition until prominent fellow investigators such as Lord Adrian (1934) began to confirm his studies [3].

3.2 The EEG-era

The history of human electroencephalography (EEG) essentially begins with the acceptance of the work of Hans Berger. Sleep research, developing along other lines, did not immediately take advantage of this technique.

The EEG era in sleep research may be said to have begun in 1935 when Loomis, Harvey, and Hobart, made the first classification of the electrical activity of the human brain during the sleep (cf. ref. [3]). These investigators described five different patterns of electroencephalographic activity which they labeled A through E, and which they reported could be observed with different states or levels of sleep. They suggested that a change in level of consciousness was connected with each change in wave-type. However, it was not until 1953 when Aserinsky and Kleitman first reported that sleeping subjects typically exhibited two kinds of eye movements, slow and rapid (cf. ref. [3]), that the scientific world was really awakened to the implications of the Loomis *et al* work. In expanded study reported in 1955, Aserinsky and Kleitman investigated the rapid eye movement (REM) sleep state and its relation to dream reports and found that the slow eye movements occurred in three-to-four second intervals and the REM appeared in clusters that recurred several times during the night. When subjects were awakened during the REM periods, 20 out of 27 replies detailed dream descriptions; in contrast 19 out of 23 subjects awakened during Non-REM (NREM) periods reported no recall of dreaming.

The importance of Aserinsky and Kleitman's discovery was emphasized by Dement's classic demonstration of the "need" for REM sleep (1960), cf. ref. [3]. Dement found that after repeated awakenings from REM sleep, on subsequent night of undisturbed sleep a higher average amount of REM was observed (REM-compensation). The discovery of the REM state sparked renewed interest in the examination of physiological measures during the sleep. It has now been shown that REM periods are accompanied by: a general increase in autonomic activity including heart and respiration rates and systolic blood pressure; a greater frequency of nocturnal penile erections; an increase in level of oxygen consumption; a decrease in oxygen supply; an increases in the secretion and osmolality of urine and changes in the circulating levels of plasma 17-hydrocorticoids; a general desynchronization of neural firing and an increase in neural activity in the motor and sensory areas of the brain; an increase in cerebral blood flow; a rise in brain temperature; and a decrease of tonic muscle activity (muscle tone in head and neck, reduction in spinal H-reflex).

Williams, Agnew, and Webb began at the University of Florida Sleep Laboratories in the early 1960s to establish baseline for EEG sleep in normal

humans (cf. ref. [6]). The original objective in investigating normative sleep EEG patterns of all age groups was to describe the ontogenetic progression of human sleep pattern and to provide baseline data for later studies of sleep disorders and for studies of the relationship of sleep and sleep disturbances to psychopathology.

4. EEG AND SLEEP DISORDERS

The discovery of the human electroencephalogram (EEG), followed by the technology to study the electrophysiology of sleep, has made possible objective measurements of patients suffering from sleep disorders. The advent and development of computer technology has made the storage and the analysis of EEG sleep data quicker, less complicated and less expensive.

The electroencephalogram (EEG), electrooculogram (EOG) and electromyogram (EMG) are the basic measurements commonly performed in all sleep laboratories (EEG + EOG + EMG = PSG, *polysomnography*). In addition, the electrocardiogram (ECG), blood pressure, respiration rate and amplitude, plus a variety of special measurements such as penile tumescence, penile blood pressure, blood oxygen saturation, temperature, and others.

The etiology of most sleep disorders is not known; however, PSG studies have made it possible to describe both qualitatively and quantitatively the electrophysiological characteristics of normal and disturbed sleep. Numerous sleep-variables have been examined and although may differ from laboratory to laboratory and from study to study, there are certain dimensions of sleep which are being examined in sleep disorders. Some of more frequently used include [7]:

(1) The *time in bed* (TIB) which is measured from the time the subject is settled in bed until the EEG is turned off in the morning (mean by 20-29 old males - 442.23 min);

(2) The *sleep period time* (SPT) which is the time in bed less the time it took the subject to fall asleep after the lights were out and less the time he lay in bed after awakening in the morning (mean - 424.64 min);

(3) The *total sleep time* (TST) which is the sleep period time less any time the subject spent awake during the night after the initial sleep onset;

(4) The *percentage of each sleep stage* (stage 1,2,3 and 4 NREM, and REM-period) which is usually computed as a percentage of the sleep period time that is occupied by a given sleep stage;

(5) The *sleep onset latency* which is considered to be the time from lights out until the appearance of the first or second sleep stage;

(6) The *number of stage shifts* which is the number of times sleep changes from one stage to another;

(7) The *number of awakenings* (NAW) as indicated by the presence of "stage 0" are commonly counted;

(8) The *latency of each sleep stage* which is the time from sleep onset to the appearance of a given stage;

(9) The *stage sequencing* which is the order of appearance of each sleep stage; it has been reported in the normal sleep profiles and in the study of some sleep disorders;

(10) The *sleep efficiency index* which is measure derived by dividing the total sleep time by time in bed;

(11) The number of *rapid eye movement* (*REM*) *periods*, the *REM period length*, the *REM interval* and the *REM density*, all of which are measures which have been examined in normals and may be important in understanding certain sleep disorders.

(12) The *ratio of REM sleep to NREM sleep* (I.E.P, Index of Endogenous Perturbation; Ilankovic N., 1983.) has been studied in normals and appears to be important in understanding sleep disorders [8].

In our studies ("Sleep Center Belgrade") after analysis of polysomnogram (PSG), 130 basic and derived parameters were designated as the "*Electrophysiological Profile of Sleep*" (EPS) [9].

4.1 The advance in technology of polysomnography

The classical registration and analysis of polysomnography (EEG + EOG + EMG) is made according to accepted standards (Rechtschaffen and Kales, 1971) [7]. In sleep laboratory it is a registration over the night (from 10 p.m. to 6 a.m.) or over 24 hours with many limitations.

The big advance in technology of polysomnography is the utility of *ambulatory polysomnography*, which implies the recording of physiologic data during the sleep from a subject who is free from attachment to stationary physiologic recording devices.

The earliest methods of ambulatory monitoring employed the transmission of data to a remote display and/or recording device. Data transmission was accomplished using radio frequencies and telephone. These methods were employed as early as 1921 for EKG, and 1949 for the recording of EEG. However, the technologist must go to the home of the patient at the beginning and end of study to attach electrodes, set up equipment, establish the telephone connection and reverse the process of the end of the study.

More recently developed ambulatory monitoring systems allow for the recording of data on a tape recorder directly attached to the patient/subject - *cassette polysomnography*. These devices currently record in an analog mode and can store large amounts of data on an inexpensive medium (audiotape). Although the "Holter

Electrocardiographic Monitor" was first designed in 1961, a multichannel recorder suitable for polysomnographic application did not become available until 1971. Wilkinson was the first to report polysomnographic cassette monitoring of acceptable technical quality in 1973 [10].

4.2 Clinical applications of cassette polysomnography in sleep and sleep-related disorders

The ASDC (Association of Sleep Disorders Centers) nosology divides the sleep disorders into four large groups: (1) DIMS (insomnia), (2) DOES (excessive somnolence), (3) Disorders of sleep-wake schedule, and (4) Disfunctions associated with sleep, sleep stages, or partial arousals (parasomnias).

(1) *Insomnia* is a disorder of initiating or of maintaining sleep (DIMS). Ambulatory cassette polysomnography (ACPSG) in patients with insomnia has demonstrated sleep apnea, narcolepsy and periodic (leg) movements (PLM) in more than 70 % of cases. Many patients have elevated Number of Awakenings (NAW) - fragmentation of nocturnal sleep, according to our Model of Exogenous Sleep Perturbation (Ilankovic N., 1983) [8].

(2) *Hypersomnia* disorders are also known as disorder of excessive somnolence (DOES). The patients with hypersomnia have two groups of symptoms: complaints about excessive amounts of sleep and complaints about excessive daytime sleepiness (somnolence). According to a recent survey, the most common conditions responsible for hypersomnolence severe enough to be evaluated by all-night recordings or by ambulatory cassette polysomnography (ACPSG), were sleep apnea and narcolepsy. ACPSG in patients with narcolepsy has demonstrated: multiple brief spontaneous naps, many with sleep-onset REM periods (SOREMPs), and disrupted nocturnal sleep. A day time Multiple Sleep Latency Test (MSLT) - several recorded naps at two-hour intervals shows very rapid sleep onset an usually one or more SOREMPs. NREM-narcolepsy is a idiopathic or symptomatic (!) hypersomnolence and it is characterized by recurrent daytime sleepiness, but sleep attacks (cataplexy, sleep paralysis) do not occur, because the sleepiness is not as irresistible as in narcolepsy (REM-narcolepsy).

(3) Extended monitoring (ACPSG) may be most directly applicable to *disorders of the sleep-wake schedule*. These disorders are characterized by the patients inability to wake at desired times despite achieving normal overall amounts of unimpaired sleep or to sleep at the desired time despite a normal preceding period of wakefulness. These disorders are truly circadian in nature and demand extended monitoring for thorough evaluation. Among the more common of the disorders of sleep-wake schedule is that occurring with changing shift work. The implications for worker safety and productivity are enormous. "Jet lag syndrome" is the other most

common type of this disorder. Long-term ambulatory temperature monitoring has been useful in understanding delayed sleep phase syndrome.

(4) Reports concerning the use of ACPSG for *parasomnias* are yet forthcoming. The combination of ambulatory monitoring and videotape monitoring is helpful in diagnosis for certain parasomnias e.g. sleepwalking, sleep terror disorders (both - stage 3,4 NREM), nightmare (REM), head banging (pre-sleep period or light sleep), etc.

In addition to these applications, ACPSG has begun to uncover the relationship between sleep and various medical disorders. The peak time of day for sudden cardiac death occurs at the REM-sleep rich period of 5 to 6 a.m. ACPSG has been employed to study the relationship of ventricular ectopia to sleep stages.

Ambulatory monitoring has been applied to other systemic dysfunctions associated with sleep, including esophageal reflux, impotence, etc.

5. THE MODELS OF EXOGENOUS AND ENDOGENOUS SLEEP PERTURBATION®

In our study on the example of the depressive disorders, we would like to point out the importance of the measurable variables of Electrophysiological Profile of Sleep (EPS) as the components in differential diagnosis of reactive and endogenous mental diseases. The sleep disturbance very frequently seen in depressive conditions is the initial basis for the discovery of certain neurophysiological parameters of nocturnal sleep that could be used as indicators of endogenic perturbation in chronobiological functions of brain [9].

Selection of the sample, precise neurophysiological measuring and exact statistical testing result in establishing new indicators of changes in internal sleep structure as factors used in the appraisal of the qualitative switch from the biologically adapted state to the development of biological/endogenic perturbation.

In this way, using only 2 parameters (of 130 available) of the first period of nocturnal sleep (registration time is shortened from 8 to 1 hr!), the problem of exact classification of new patients in group with and without endogenic perturbation of sleep (with reactive and with endogenic depression), seems easier to solve.

Practical application can be seen in the following example of classification function (Discriminative Profile of Sleep, DPS), for STAD-1,4 (4th stage of the 1st period) and REM-1 (first REM period, SOREMP):

$$(k1 - k2) \times STAD - 1{,}4 + (k1 - k2) \times REM - 1 \begin{cases} > K1 - K2 \ (\textit{exogenous depression}) \\ < K1 - K2 \ (\textit{endogenous depression}) \end{cases}$$

where

k1=1.023, k2=0.135 (for STAD-1,4)

k1=1.263, k2=1.935 (for REM-1)

K1=-44.565, K2=-66.789

The statistical *model of exogenous perturbation of sleep*, characteristic of exogenous/reactive (depressive) states consists of:

(1) The increased Number of Nocturnal Awakenings (NAW) - statistically the most important phenomenon

(2) Shortened REM-sleep,

(3) Prolonged first sleep period,

(4) Decreased REM/NREM Ratio.

The *indicators of development (progress/regression)* of endogenic perturbation are also determined:

(1) Decreased NAW,

(2) Reduction of "delta-sleep' (stages 3 and 4 NREM),

(3) Shortened first period of night,

(4) Increase of total wakefulness.

The statistical *model of endogenous perturbation of sleep* found in endogenic depression (mania, OMD, schizophrenia, paranoid states, anorexia, alcoholism, and in different time of development/maturation of human brain!), is composed of the following parameters of nocturnal sleep:

(1) Shortened REM-latency,

(2) Reduction of "delta-sleep",

(3) Increased of Index of Endogenic Perturbation (IEP),

(4) Prolonged REM-l phase (SOREMP)

6. INDEX OF ENDOGENOUS PERTURBATION OF SLEEP (IEP)®

Neurophysiological measurements of the internal organization of sleep (REM/NREM alteration) in our studies were exposed to special statistical testing - the parameter approach in discriminative analysis [10].

The results of our investigations demonstrate that this parameter (IEP) is a highly reliable indicator of the development/regression of *endogenic perturbation of*

sleep in depression, mania, schizophrenia and other psychotic states (altered states of consciousness), organic brain syndrome, etc.:

IEP = REM/NREM	(Index of Endogenous Periodicity)
IEP-P1 = REM-1/NREM-1	(Index of Endogenous Perturbation)

In healthy child who is 30 weeks old IEP = 4 , in 1st year >1, in healthy adult (25 years old) the mean value of IEP = 0.44, in old men (60 - 70 years old) < 0.4.

On the other hand, in reactive states is IEP-P1 = 0.77 (reactive depressed), but in pathological states (in states of altered mental function, altered states of consciousness and in specific psychotic states - "transcommunication states", Ilankovic N., 1986) the alteration of sleep periodicity is very deep and the Index of Endogenous Perturbation (IEP-P1) is very high:

- in schizophrenia-like states ("hypocommunication states", Ilankovic N., 1986), IEP-P1 < 0.3 ,
- in endogenous depressed, manic and paranoid states ("hypercommunication states", Ilankovic N., 1986), IEP-P1 > 2.40 !

The importance of this index can be seen in clinical approach (in classification of different states/type of mental illnesses, evaluation of therapy) and in further research of chronobiological mechanisms of brain, biological aging of brain, specific states of altered consciousness and "transcommunication states" (?), and in biophysical modeling of sleep (brain) mechanisms (Ilankovic N., 1995).

7. NEW FRONTIERS IN SLEEP RESEARCH

We are inclined in our new approach in explanation of sleep mechanism, to support hypothesis that sleep patterns and circadian cycle wakefulness-sleep, are building blocks in some greater natural rhythms, shaped by interaction of external stimuli and internal performances of CNS, with certain adaptive and protective feature.

Having that in mind, we have created the hypothesis about *passive and active protective "help" systems*, which, through sleep, *protected the brain from critical cooling* (!) (Ilankovic N., 1986,1990) [2].

In fact, reducing brain tissue's temperature would lead to regression of brain's electrical activity during NREM sleep, while through active processes of REM sleep metabolic homeostasis and homeothermic conditions would be regained. NREM periods are time when nature is trying to cut down some energy spending by "passively preserving it" - "*passive help system*". This is managed by progressive

inhibition of telencephalic activity and by marked reduction in muscle tone (disconnection of telencephalic region from rhombencephalic motor mechanisms). Since inactivation of great muscle groups is offering bad "saving plan" due to their significant role in thermoproduction, "*active help system*" is handling this thermonergetic disbalance and keeping the brain away from critical cooling point: through REM sleep the active neuronal and metabolic processes in brain stem are released. They include increased cerebral blood flow, increased glucose utilization and rising brain tissue's temperature! Owing to these active processes, brain is protected from critical cooling and yet another life saving and function preserving mechanisms are in effect.

This hypothesis tackles not only well known electrochemical processes in neuronal function, but also some phenomena concerning *electromagnetic induction* (Ilankovic N., 1990). Investigations of these phenomena are in focus of scientific work and research in our "Sleep Center" of University Clinical Center in Belgrade.

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DETERMINISTIC CHAOS IN EEG SIGNAL

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Abstract. The paper discusses some basic concepts of registration and analysis of brain electrical activity, i.e. electroencephalography (EEG). An introduction to the theory of deterministic chaos, and selected results of contemporary application of this theory in the analysis of EEG and other biological signals are presented. The original method of chaos analysis is shown theoretically and applied to normal and pathological EEG signals.

Keywords: *EEG, chaos, disorder of consciousness, petit mal absence epilepsy, cognitive neurosciences.*

1. ELECTROENCEPHALOGRAPHY (EEG): BASIC CONCEPTS

In the past ten years studies of electromagnetic brain activity during cognitive processes have had two important innovations. The first one was technological: the application of superconductors enabled the measurement of brain magnetic activity. The second innovation was conceptual: the theory of deterministic chaos was applied to the analysis of biological signals. In this paper, we present some aspects of this theoretical application to EEG signal analysis of disordered consciousness during an epileptic seizure and immediately prior to its onset.

EEG is a neurophysiological method that is used, inter alia, for analysis of spatio-temporal patterns of brain electrical activity during psychic processes. This aspect of neurophysiology is a constituent of cognitive psychophysiology, an interdisciplinary science that studies physiological functions underlying psychic phenomena. Cognitive psychophysiology, cognitive psychology and computer modeling constitute *cognitive neurosciences*. This is the broadest frame of application of the theory of deterministic chaos discussed in this paper.

Among the biological methods, only studies of brain electrical (and magnetic) signals can trace changes that take a fraction of a second. Therefore, these methods are convenient for analysis of fast changes in the activity of neural systems that occur during mental operations.

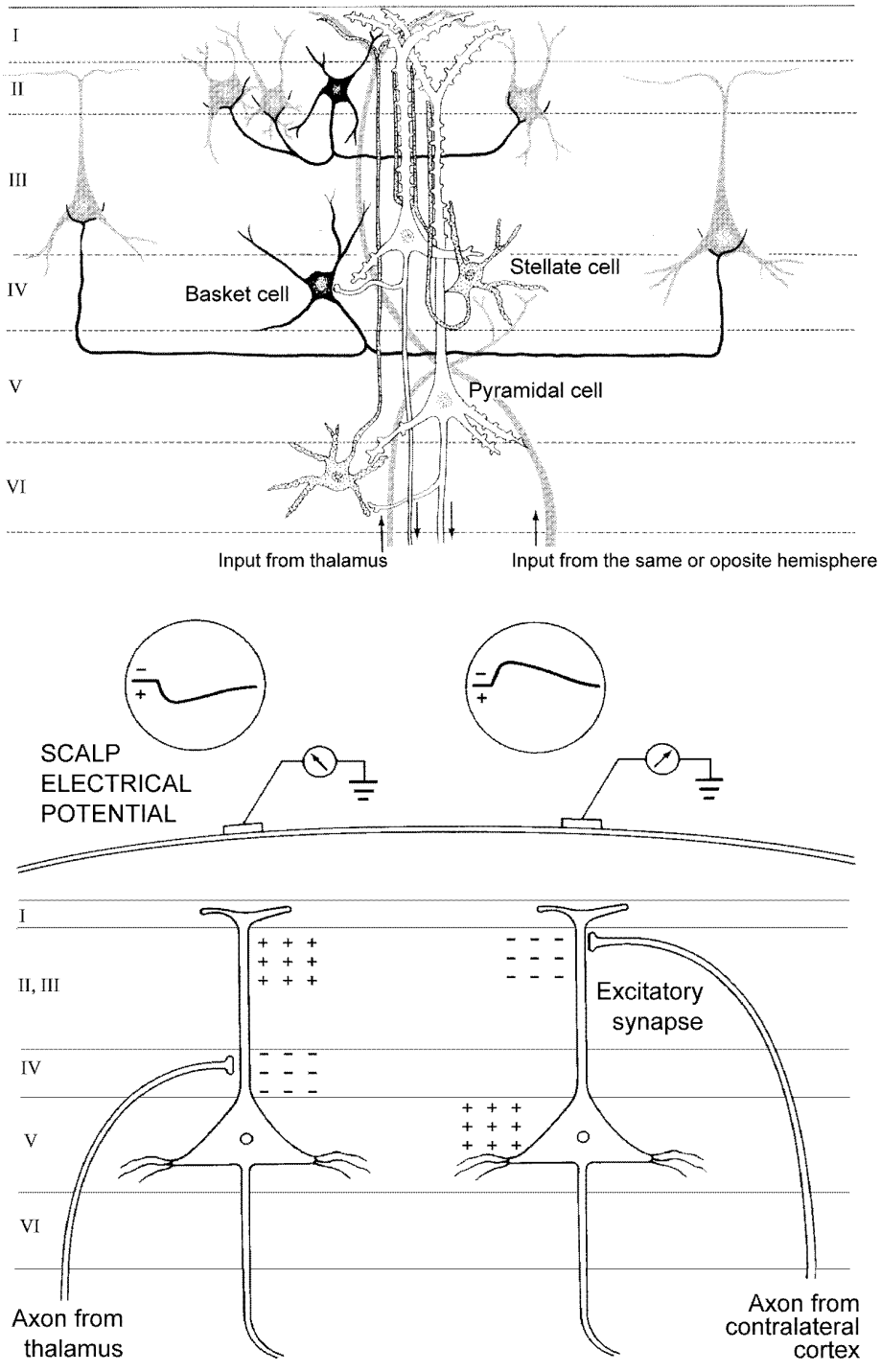

Figure 1 Cerebral cortex as electrical field generator [1].

In this paper, only basic concepts of generation and measurement of brain electrical activity, necessary for understanding subsequent paragraphs, will be explained.

In the upper part of Fig. 1, the scheme of the *cortex* is given (six-layer neocortex) with the main types of nerve cells *(neurons)* and their connections: pyramidal cells in layer III and V are multiply connected by interneurons (stellate cells) in layer IV; basket cells are inhibitory. The main excitatory inputs in the cortex derive from a specific relay subcortical structure - the *thalamus* (thalamic afferents, mostly to layer IV), and from the same or opposite hemisphere (association and calosal afferents - mainly to the layers II and III). The main output from the cortex are cell extensions (axons) from layers II, III, V and VI. Each neuron is connected with several thousand other neurons, and the number of functional circuits they form is immeasurable.

The lower part of Fig. 1 illustrates the generation of brain electrical activity. During the transmission of signals (excitatory and inhibitory) through cell connections *(synapses)*, electrical changes of cell membranes are induced *(postsynaptic potentials)*; electrical fields generated by the difference in charges produce current flow from fields of positive to fields of negative potential. Current flow produces *electromagnetic fields* that spread to the cranial surface (scalp), and can be measured there by precise instruments. Summated activities of thousands of nerve cells give surface potentials in the range of microvolts (μV).

The registration of the fluctuation of summated brain electrical potentials by contact electrodes from the scalp is shown in the upper part of Fig. 2. Electrical potentials are amplified by the EEG instrument, filtered, and reproduced as an analogue signal, i.e., a continuous curve on paper (EEG trace). A computerized procedure of analogue-to-digital (A/D) conversion [2] converts the EEG signal to a series of numbers which represents its amplitude in time; this representation of the signal is called the *time series*. This transformation enables further mathematical analyses of the signal.

The normal EEG signal of the adult in a relaxed awake state is given in the lower part of Fig. 2. The EEG signal is registered from a number of predefined head locations that correspond to anatomical-functional brain regions. In this way, several simultaneous time series or traces, i.e., *EEG channels*, are obtained. The sinusoidal signal of 50 μV amplitude and 10 Hz frequency which dominates the channels above the posterior head regions (Fig. 2, part 1) is called the α *rhythm.* Parts 2, 3, 4, and 5 of Fig. 2 illustrate normal variations of brain activity in the α frequency domain (8-13 Hz).

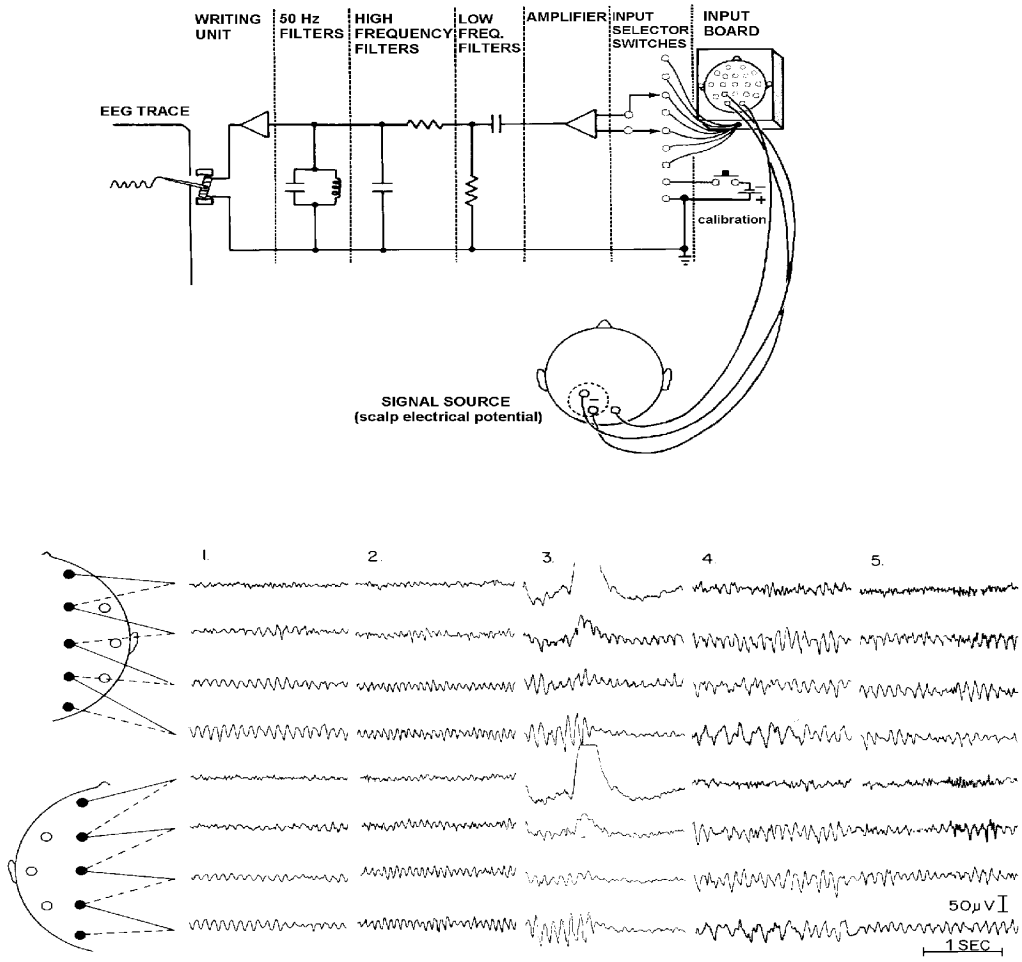

Figure 2 Registration of electrical potentials from the scalp, and an example of a normal EEG signal [3].

In the EEG signal, it is possible to register frequencies ranging from 0.3 to 40 Hz by standard recording techniques. Special techniques are required to register other lower and higher frequencies. Alpha activity is an example of oscillatory functioning of neural assemblies: wide cortical regions are interconnected with the thalamus, and, due to co-interaction of these structures, 10 Hz oscillations are generated. For α rhythm, oscillations of the same frequency are also generated by cortico-cortical interactions of neural assemblies. Isolated neurons also have an oscillatory type of electrical activity, usually in the range of 1-20 Hz. However, intrinsic properties of the neurons are controlled by the influences from functional circuits to which these neurons belong. Both the intrinsic properties and the synaptic

interactions of large neuronal assemblies are necessary for generating the brain rhythmic activity [4]. The biological function of α rhythm has not been fully elucidated; it is possible that such slow potentials, spreading over large cortical areas, can influence the activity of neural assemblies by electric conduction. Speaking in general terms, this standpoint can be transformed into an assumption that electromagnetic fields of low intensity and frequency which spread over large cortical areas, generated by neural electrical activity, can in turn influence the activity of individual nerve cells [5]. If this proves true, electromagnetic fields of this kind can play a significant role in mass neural information processing; at the same time, this provides an argument contrary to the standpoint that brain electrical activity is only an epiphenomenon.

The oldest method of analyzing the spatio-temporal properties of a brain electrical field is the visual inspection of EEG signal by an expert. This method is empirical and it is used almost exclusively in clinical settings, so it will not be a subject of our further consideration. For purposes of research, the computerized method of brain electrical field analysis is most commonly used.

Fig. 3 illustrates a possibility of visualization and quantification of this *changeable electrical field*. It is a computerized reconstruction of its spatio-temporal configuration. The EEG is registered from several spots on the head surface, e.g., by 8 channels. From the digitized amplitude values for each channel isopotential lines are constructed. They form the contour map of distribution of electrical potentials in space (head surface) and time. White areas represent the electropositive and black areas the electronegative field. The speed of field configuration changes can be read from the abscissa, which gives the time in milliseconds (ms). Therefore, particular configurations of the brain electrical field, determined by spatial coordinates and time, are identified as real *spatio-temporal structures* with specific dynamics.

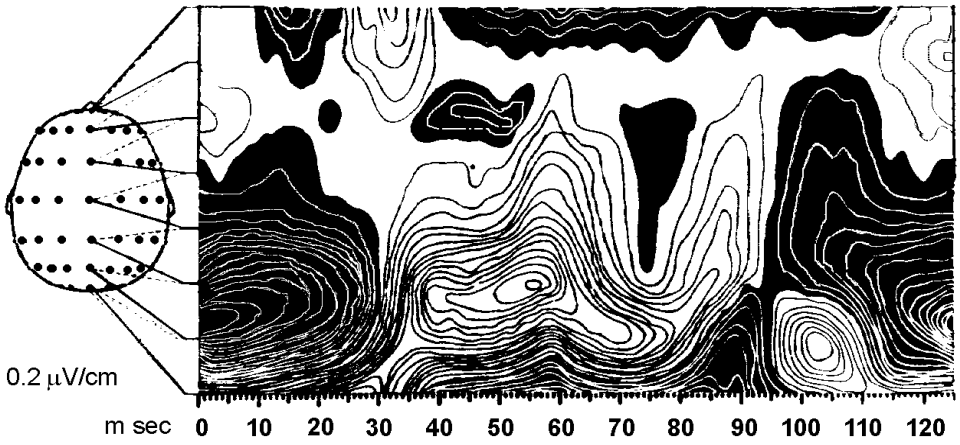

Figure 3 Topographic map of brain electrical fields changing in time [6].

2. INTRODUCTION TO THE THEORY OF DETERMINISTIC CHAOS

An EEG is a typical example of a signal with several frequencies, complex form, and unpredictable or hardly predictable evolution in time. Nevertheless, it is not necessary for such a signal (time series) to be described by a large number of complex equations. Even ancient philosophers and mathematicians recognized simple systems that produced unpredictable behavior, but due to the lack of analytical apparatus they could not advance from anecdotal examples and rhetorical points. Among the more recent considerations of this problem, the first is the famous discussion on the problem of three bodies in the book on celestial mechanics by Henri Poincaré from 1892. Robert May, a contemporary researcher, was among those who first showed [7], mathematically, that *simple models do not necessarily produce simple behavior* (see Fig. 4).

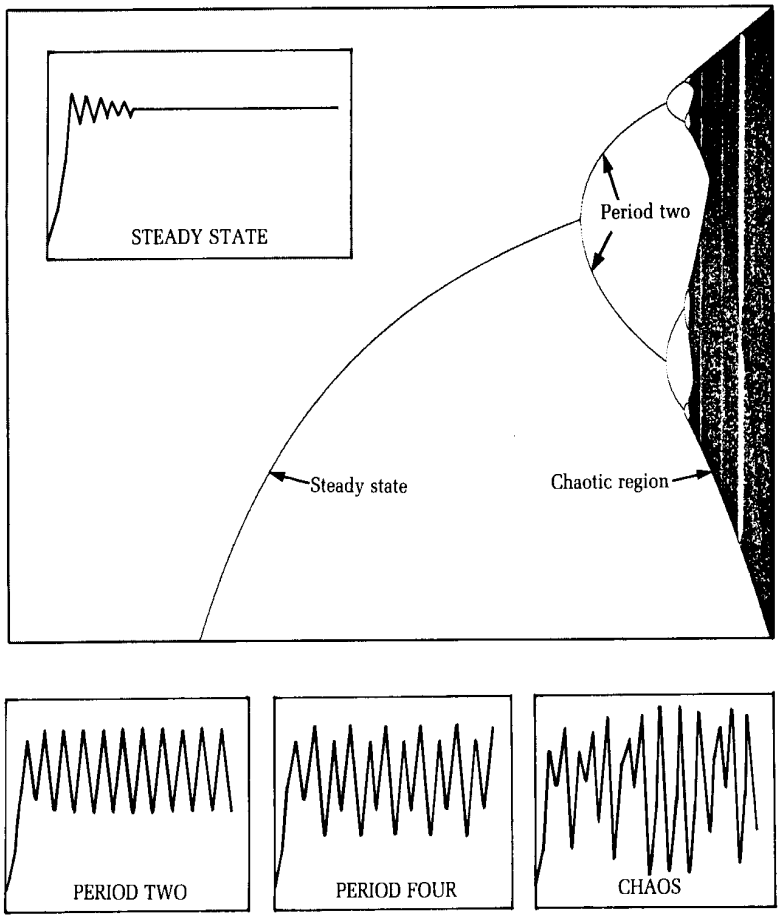

Figure 4 Emergence of chaos by bifurcation [8].

The mathematical function that gives the graph in Fig. 4 is: $X(n+1) = r \cdot X(n) \cdot (1-X(n))$. It can represent an approximation of real phenomena, e.g., the chronological evolution of the size of an animal population in a closed environment. Every value of population X(n+1) depends in a *non-linear* way on its preceding value X(n), and on some parameter r which regulates its behavior. (Non-linear dependency is more easily observed if the formula is written in an alternate form as $f(x) = 1-r \cdot x^{2,}$, where x^2 is the non-linear member). By increasing the parameter r from zero up to a certain value, the population first oscillates, and finally achieves a *steady state*. Further increases in parameter r cause *periodical behavior* of the size of the population: the two values interchange, e.g., population have the same size every other year (period two). If the value of r is further increased the periods are multiplied (period four, eight, etc.), and finally, if it exceeds a critical value $r \approx 3.57$, *chaotic behavior* appears. In the chaotic region, after some time, it is impossible to predict the *next value of the point*, since the small differences in values of points X(0) and X′(0) will create large differences in values of points X(n) and X′(n). The above example is only one of the scenarios of a dynamic system's transition to chaos [9].

From the above example of a process that has become chaotic in time *(temporal chaos)*, two basic characteristics of all chaotic systems can be seen. 1) There is only a short-term predictability of the system's behavior. This is a consequence of rapid, exponential divergence of neighboring points, which can be quantified by calculation of so-called positive exponents of Lyapunov [10]. This leads to 2) *extreme sensitivity to initial conditions*: practically immeasurable differences in initial values can produce enormous differences during time evolution. These two characteristics give a stochastic picture of an essentially deterministic process. This occurs because of a "computation barrier": seemingly paradoxically, *the long-term behavior of a deterministic system cannot be estimated from a complete set of initial conditions*. It should be noted that fine variations of data are postulated here as caused and not as given by chance. It is important to remember this *principle of caused variation* since it is a basis for the description of deterministic chaos. Opposed to this principle is the principle of stochastic processes, where it is assumed that there is a random variation of every data around an average value. Measures based on the stochastic principle are the classical statistical measures such as mean, standard deviation, t-value, etc. The deterministic model introduces a fundamental *principle of uncertainty*, more general than Heizenberg's uncertainty in quantum physics, claiming that uncertainty is present not in the universe, but in the calculation (epistemic uncertainty): a complete deterministic description of one chaotic system would require infinitesimal precision in estimation of initial conditions, and hence it is impossible [11]. We shall note here that the method of EEG signal frequency analysis by Fast Fourier's Transformation [12] which has been a basis of topographic brain electrical activity mapping for a long time, is based on the assumption of stochasticity; as we shall see later, the deterministic approach is still being tested in the analyses of EEG and other biological signals.

Visual representation of the complexity of system evolution is also possible in a diagram with *coordinates that consist of some information about the system or system variables*, e.g., for the pendulum, these are angle as abscissa and angular velocity as ordinate (see Fig. 6). A *point* in such coordinate space is defined by the current values of variables. *Trajectory* of the point then represents the dynamic relation between variables in time. One type of these N-dimensional coordinate spaces is a *phase space:* trajectory of the point here also represents the continuous change of variables and their correlation. A *phase portrait* of a system is obtained if the trajectory is presented by its projection in two dimensions.

Edward Lorentz, the American meteorologist, in the effort to solve the problem of long-term weather forecasts, reduced the problem of air turbulence (instability of fluids heated from below) to three simple non-linear equations of the first order. He characterized their evolution in a 3-dimensional phase space and showed the chaotic behavior of the system [13]. With this work he laid the foundations of the theory of deterministic chaos. A review of pioneer works of the authors who in the period 1975-1989 identified and studied chaos in the fields of physics, astronomy, biology, chemistry, etc., can be seen in [14].

Lorentz's time series (time dependence of one coordinate on the graph) is outlined in the upper part of Fig. 5, while trajectory as time evolution of the system in interaction of all three variables can be seen in coordinate space. Trajectories of this system (also applied to other chaotic systems) never appear in an identical way - the chaotic system is *non-periodic* and it is also *never in equilibrium* (there is no fixed point where the system ends its evolution). Only systems with minimum of three degrees of freedom (i.e., described by minimum of three differential equations) and a non-linear correlation between variables, as in Lorentz's system, can turn into chaos. Lorentz found that these trajectories in phase space converge on the object, i.e., attractor, presented in the Fig. 5. The *attractor* is a part of phase space densely occupied by the trajectory (Fig. 5 illustrates the attractor after the evolution of a trajectory that consists of only several hundred points; theoretically, the attractor is formed when time tends to be infinite); it is as if trajectories are "attracted" to specific object.

Fig. 6 illustrates examples of attractors. The first three diagrams represent attractors of a regular shape and integer dimensions. Time series are in the upper frame and trajectories in the lower: (1) the first series consists of suppressed oscillations, e.g., a pendulum that stops; the attractor is a point of topological dimension zero; (2) one-frequency motion; its attractor is a limited circle; the dimension of the attractor is 1; (3) periodic motion of three frequencies in measurable correlation 1:2:3; the attractor is circle with period three, the dimension is 1. The fourth part of Fig. 6 is Lorentz's attractor. Since it is a part of a chaotic system, this attractor has a *fractal (non-integer) dimension* and belongs to "strange attractors".

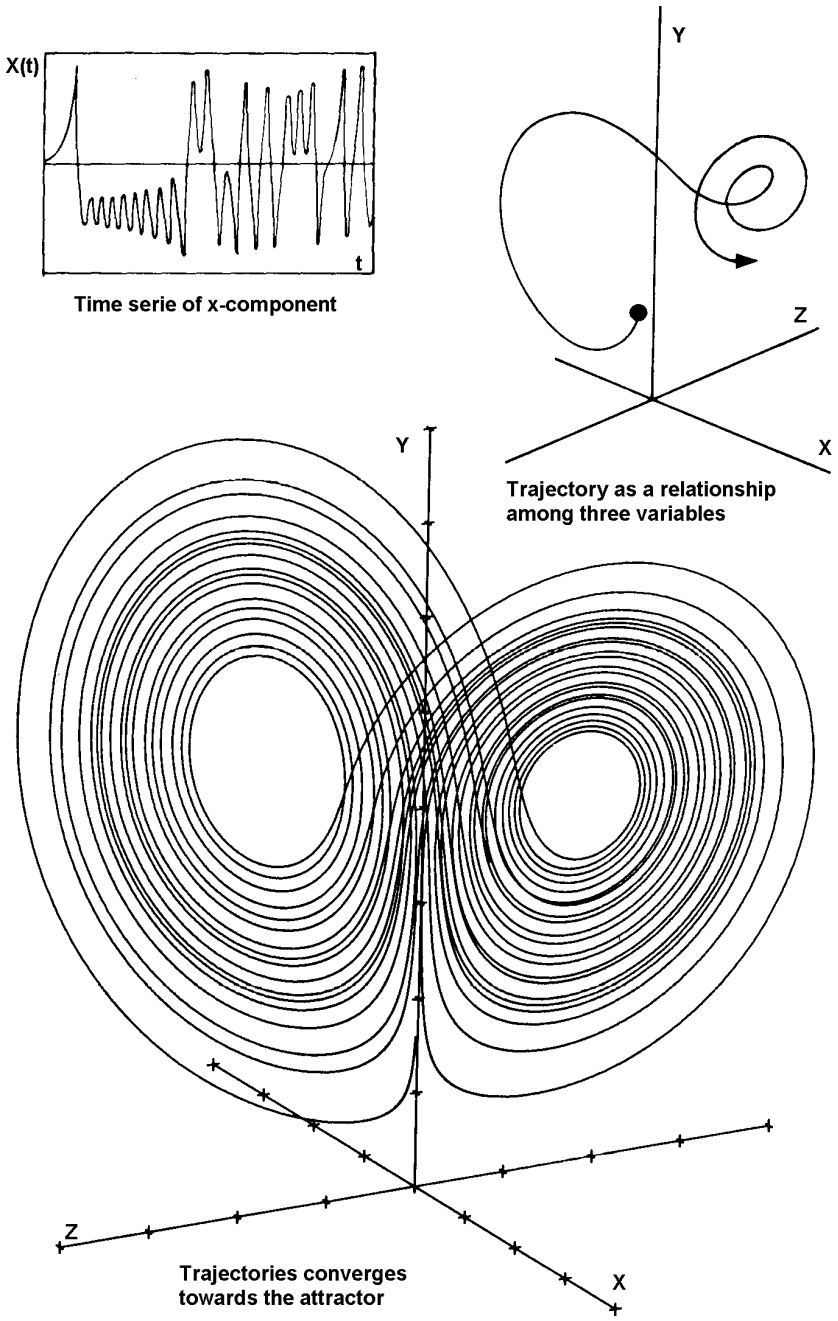

Figure 5 Lorentz's attractor [8].

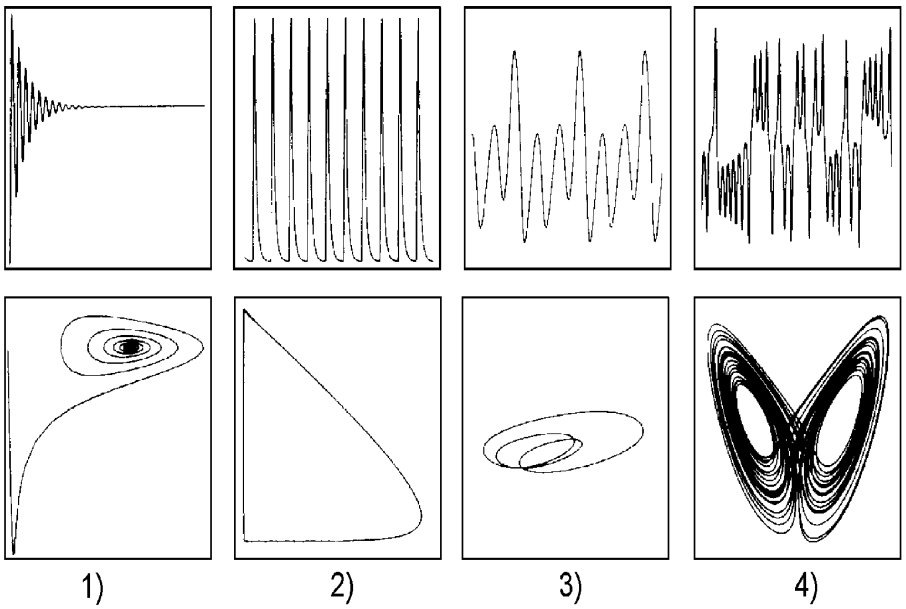

Figure 6 Phase portraits of known time series and their attractors [8].

Strange attractors are one of the main features of chaotic dissipative systems. The space of a strange attractor is curved, folded and stretched. Because of the exponential divergence of neighboring points that takes place in a finite space with decreasing volume due to dissipation, the space must "twist" so as to encompass a trajectory that behaves in this way. Thus, non-Euclidean space (hyperspace) appears. For this reason, a strange attractor has *fractal dimension* (for instance, the dimension of Lorentz's attractor is 2.06). By formal definition, a strange attractor is a limited and a connected assembly of points in phase space that attracts and captures trajectories (trajectories do not leave it). The complexity of a strange attractor is characterized by *dimensions* which are generally defined as the *number of variables for system description*, i.e., the *system's number of degrees of freedom*.

In measuring biological systems, variables that define its dynamics are most often unknown, or they cannot be expressed quantitatively, or the overall behavior is given only in one time series. Takens (1981) mathematically proved [15] that in this case we can find dimension of a system generator (i.e., number of independent variables) in N-dimensional space reconstructed from time series that have been produced by any of these variables. An attractor reconstructed in this space is equivalent to a real, unknown attractor of the system. Biological chaotic systems have low fractal dimension (most frequently ≤ 6), contrary to noise which has an infinite number of degrees of freedom. Practically, highly dimensional chaotic processes cannot be distinguished from stochastic ones.

Dimensions describing various aspects of attractors are (a) geometrical (Hausdorf's): number of coordinates necessary to describe the system; (b) topological: distribution of trajectories on the attractor; (c) informational: frequency by which a trajectory visits the attractor, a measure of loss of initial information about the system; (d) *correlation dimension (denoted by D_2)*: correlation between neighboring points on the attractor, i.e., coherence of the system dynamics (low D_2 implies high coherence, and vice versa). This dimension has been most frequently used in the analysis of chaotic systems, primarily due to the simplicity of algorithm for its computation given by Grasberger and Procaccia [16]. However, it has some drawbacks, and one of them is that a large number of points of the signal is required for its precise calculation: $1\text{-}30 \cdot 10^{D2}$ [17].

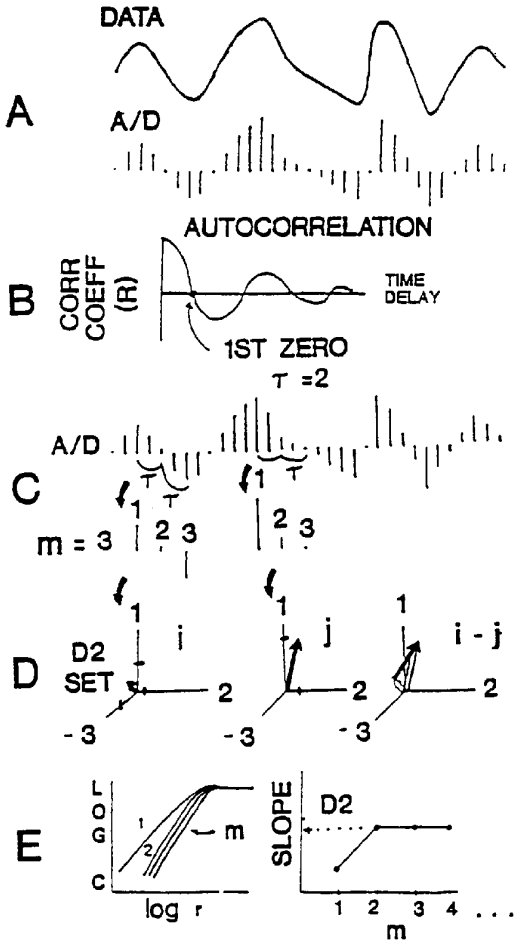

Figure 7 Calculation of the correlation dimension of an attractor by Grasberger-Procaccia's method [18].

Fig. 7 represents the scheme of obtaining the correlation dimension from a time series (DATA) by Grasberger-Procaccia's method: A) digitalization (A/D conversion) by measuring the signal in a fixed time interval; the signal is then presented by a time series (height of each line corresponds to one numerical value of amplitude); B) computation of the first zero of the autocorrelation function gives the time separation of the two points of the signal for which their correlation is zero. (time delay τ); C) signal points taken by step τ are used as coordinates for the calculation of vectors (i, j) in phase space; D) computation of all (i) and (j) vector differences; E) construction of a cumulative diagram of ranked vector differences, where the correlation dimension (D_2) is the slope of the linear part of a curve.

3. A REVIEW OF HISTORIC APPLICATIONS OF THE THEORY OF DETERMINISTIC CHAOS IN EEG AND OTHER BIOSIGNALS

Previous investigations of biological systems have identified chaos in the dynamics of heart function, endocrine system, rapid eye movements, spread of a measles epidemic, metabolic cell dynamics, function of neural membranes, morphogenesis, production of leukocytes in leukemia, etc. [19]. Based on these investigations, the first practical results were obtained in cardiology. Goldberger (1990) showed [20] that a healthy heart has the dynamics of a low-dimensional chaos and that the transition either to a higher (noise) or a lower dimension (periodic regime) is due to pathological process (e.g. in cardiac insufficiency, arrhythmia, etc.), and chaotic measures proved to be superior to stochastic ones in the prediction of fatal heart arrhythmia in patients after infarction [21]. These kinds of definite answers do not yet apply to the brain as a far more complex system: for smaller assemblies of neurons or models of specific functional systems, e.g. olfactory, there is definitive evidence of the existence of chaos [22]. Concerning the brain as a whole, it is possible to prove only for certain time intervals that it functions in low-dimensional chaos, because its function is most probably a complex *spatio-temporal chaos* (chaotic dynamics of spatio-temporal configuration of electric field) as well as chaos on several scales of system observation (microscopic-cellular, segmental-functional structures, and global).

Babloyantz et al. [23-25] and Albino et al. [26] were among those who first applied the theory of deterministic chaos to the analysis of human EEG signals. In their studies they determined the correlation dimension (D_2) of attractors of normal and pathological EEG signals.

Fig. 8 shows a selection of early results of chaos analysis in EEG: on the left-hand side of the figure is a sample of EEG signal in three different conditions, and on the right-hand side are phase portraits as qualitative aspects of these signals; from above to below: normal α rhythm, $D_2 = 6.1 \pm 0.5$ [25], deep sleep, $D_2 = 4.05 \div 4.37$

[23] and coma in Creutzfeldt-Jakob disease, $D_2 = 3.8 \pm 0.2$ [24]. It was shown that D_2 decreases from a wake α state to deep sleep and coma. This was one of the first attempts at *determination and classification of various dynamic states of the brain based on chaos analysis.*

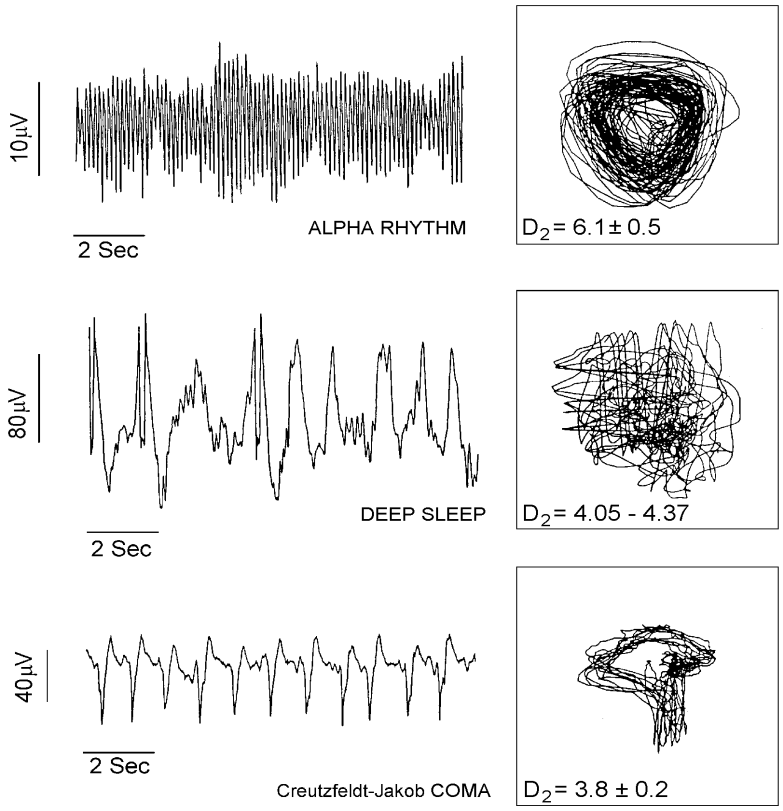

Figure 8 Early studies on deterministic chaos theory applied in EEG analysis.

Initial enthusiasm for estimating the correlation dimension decreased when it was realized that this measure was not as discriminative for various functional states of the brain. Various studies quoted different D_2 values for the same type of signal: for α rhythm the obtained values ranged from 3.8 to 11 [27], as a logical consequence of D_2 being defined as a global static measure of a dynamic attractor. Mayer-Kress et al. showed [28] that signal stationarity requirements for D_2 computation had not been fulfilled in these studies: the electrical activity generator (the brain as a whole or its functional subsystems being measured) changes pattern of activity in time, i.e. during signal acquisition there is a *transition of system from one functional regime to another.* These different regimes obviously have different attractors. It has been reported that the EEG signal is stationary, depending on

ongoing activity, from several tens of milliseconds to a few seconds, and that is mostly a range from 500 to 1000 msec [29,30]. The EEG signal, at a typical sampling rate from 100-200 Hz for A/D conversion, gives the necessary number of points for D_2 computing for a signal duration of at least 30 seconds or more, which is obviously too long for stationarity requirements to be met. Larger sampling rates do not solve this problem, because of the so-called oversampling error: false positive correlation of the too-close neighboring points gives false low values of D_2. Up to now there have been numerous attempts at solving the stationarity problem [28,30,31]. In this paper we shall present our original method which enables computation of the signal dimension for short time periods.

4. A REVIEW OF OUR METHOD OF CHAOS ANALYSIS IN EEG, WITH EXAMPLES

Since Takens has shown [15] that phase space may be reconstructed from one time series by a space coordinate as a function of time (A(t)) and a time delayed space coordinate as a function of time (A(t+ Δt)), the *qualitative aspect of system dynamics* may be obtained from a *phase portrait* of the attractor in this two-dimensional space (see Fig. 9 and subsequent figures).

Our method [32] reconstructs the attractor of EEG in an *8-dimensional phase space*, with the *space position of electrodes and the time* as coordinates (2-dimensional phase portrait of normal EEG signal in Fig. 9 is given only as an illustration of the method). We shall start with a necessary assumption that the brain waves are real physical waves that traverse the brain surface with a certain quantity of *energy* [33]. In short fixed time intervals (15-1000 msec) we take *a point on the signal* and determine the corresponding *point on the attractor.* For the assembly of 30-50 neighboring points belonging to a unique linear hyperplane *(*the *local linear part of the attractor),* it is possible, by applying the theory of linear operators, to compute the following:

a) Dimension of this local space, as a minimal number of orthogonal directions defining its position in phase space: this is the *local topological dimension of the attractor*. In order to simplify the diagrams, this dimension will be expressed as the first integer value larger than the fractal one. This dimension, as the previously mentioned ones, reflects the number of the system's degrees of freedom.

b) Signal complexity, as distribution of energy in dominant spatial-temporal structures (modes) of the brain electrical field. The formula for computation of this complexity is:

$$H = -\frac{1}{\log N}\sum_{k=1}^{n} p_k \log p_k .$$

where p_k is the probability of occurrence of one spatio-temporal structure (STS):

$$p_k = \frac{\text{energy of one STS}}{\text{total energy of all STSs}}.$$

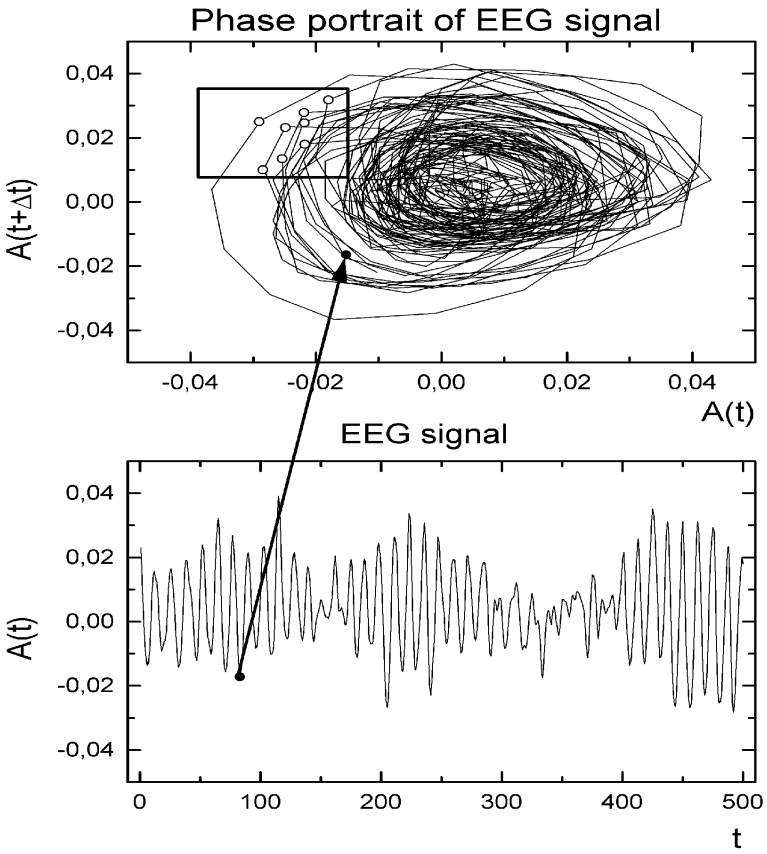

Figure 9 Normal α activity and its phase portrait, with a scheme of local linearization of attractor (see the text for explanation).

Complexity defined in this way is *informational entropy (H)*, defined in range from 0 to 1 by the normalization coefficient - 1/log N. It represents the degree of chaoticity of the system in a way that measures the loss of initial information about the system and the creation of a new one during the time evolution. It is the quantity of information necessary to describe the system in a discrete point of time (number of dominant modes in our methodology). Entropy is maximal (H = 1) when the energy is uniformly distributed across all the directions of the attractor, i.e., spatio-temporal modes. In other words, entropy is maximal if the distribution of probabilities for spatio-temporal structures is Gaussian: hence, this entropy

measures the degree of divergence from the Gaussian distribution. For a weakly Gaussian distribution, $H \geq 6$; for a quasi-periodic signal, $0.3 \leq H \leq 0.5$; and for a deterministic periodic signal, $H \leq 0.3$. The distribution of probabilities of oscillations of a membrane potentials of an isolated neuron is not Gaussian [34]. For α waves it is close to Gaussian for time interval less than 2 sec [35]. These facts could be interpreted only in two ways: (1) neurons are statistically independent - which is obviously an incorrect assumption since brain neurons are remarkably functionally interconnected; or (2) *neurons are nonlinearly coupled* (already proven for small neuron ensembles, e.g. olfactory system) and *work in a desynchronized way* (which is self-evident from the calculated value $H \neq 0$, i.e., if neurons work in completely synchronized way $H = 0$).

Non-linear coupling of neurons and desynchronized work provide prerequisites for the explanation of brain functioning as chaotic. Our information entropy, by measuring probabilities of occurrence of spatio-temporal modes, at the same time measures the *global degree of synchronization and desynchronization of neuronal work.* Our method provides a *continuous analysis* of the EEG signal in time, and it is also sensitive to signal changes of very short duration. Furthermore, it can be applied to small spatial regions. Time resolution of our method is limited only by technical possibilities of A/D conversion (practically not shorter than 0.5 ms), and spatial resolution only by inter-electrode distance and their number (practically not shorter than 2 cm). The entropy that we calculate may be defined as spatial or temporal (the first measures changes of complexity in space, the other in time), or as a global (spatio-temporal). In our examples [36] we applied this method to the analysis of two EEG signals of two six year old children: *we estimated the temporal entropy and the local topological dimension* of the EEG signal for each brain hemisphere (shown results are for the left hemisphere only, since they are almost identical with those of the right one), and for three functional brain states: normal EEG, epileptic seizure (petit mal absence), and EEG two minutes prior to its onset. Standard EEG registration was performed.

Details of the registration technique: Ag/AgCl scalp electrodes of impedance < 5kΩ, applied according to 10-20 International system, 16 channels (F7, F8, T3, T4, T5, T6, Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, all to av. reference), Medelec 1A97 amplifier, sensitivity 50 μV/cm, bandpass 1-70 Hz, 50 Hz filter off, A/D conversion on 12-bit DT-2801 card, 128 Hz sampling rate, software for signal acquisition Rhythm v 8.0 Stellate Systems, off-line elimination of artifacts and chaos analysis by our own software.

Fig. 10 (A) illustrates the normal EEG signal just in one channel (left parietal), and Fig. 10 (B) is its phase portrait. Fig. 10 (C) represents the entropy fluctuation of the left hemisphere (8 channels) in time (128 points of the signal is 1 sec) that has a stable value around $H = 0.6$, which denotes a weakly Gaussian distribution of probabilities of spatio-temporal structures. In Fig. 10 (D) one can see

oscillations of the value of the dimension from 6 to 7 (number of degrees of freedom) for the left hemisphere. All of these values are normal.

Fig. 11 (A), illustrates again the left parietal EEG channel. The arrow points to the high-voltage epileptic paroxysm (consisting of rhythmical spike-and-wave complexes at 3 Hz) during a clinically evident petit mal absence seizure lasting approximately 18 sec. In the later part of the signal, a few more epileptic paroxysms can be seen, but they are of lower amplitude, of a much shorter duration and were not accompanied by a seizure. The phase portrait (Fig. 11 (B)) during the epileptic seizure clearly differs from the phase portrait of the normal signal: here, the complexity is much lower, the trajectory is almost forming a limit circle (which would correspond to dimension of 1) or a torus (dimension 2). The exact value of this low dimensional process (small number of degrees of freedom) can be seen in Fig. 11 (D), where values below 2 belong to the seizure (in a rectangle). After the seizure its values are somewhat higher (ranging up to 4 or 5), but still below those of the normal signal. In parts of the signal that have short paroxysms that are not accompanied by epileptic seizure, there is a moderate decrease of the dimension values, but not below the value of 2 as seen during the seizure. The *decrease of complexity* in the system can be seen as well from the entropy values which fall during the seizure to values around 0.2 (Fig. 11 (C), in the dotted rectangle). Immediately after the seizure, values for the entropy rise toward the normal ones, but they do not reach them. This decrease of complexity in the system (brain functioning) during the epileptic seizure is clearly due to the *increased synchronization of neural work*, e.g., decrease of chaoticity and transition to a (quasi)periodic regime. In this EEG signal, it is seen as an occurrence of a generalized paroxysm of uniform and rhythmical elements. The whole energy of the system is in one mode, the complexity is conspicuously low, so it can be said that there is a great *loss of information* in the system, in comparison to the normal state. This could explain the loss of consciousness that occured during the seizure.

Fig. 12 illustrates the EEG record of the same child, two minutes before the above mentioned seizure. The signal shape (Fig. 12 (A)) and its phase portrait (Fig. 12 (B)) do not differ much from those of the normal signal. However, values of the entropy (Fig. 12 (C)) are much lower than those for the normal signal, ranging here from 0.2 to 0.3, but they do not reach values below 0.2 which they had during the seizure. The signal dimension (Fig. 12 (D)) range from 3 to 5, and that is well below values for the normal signal, but still higher than for the seizure. These results demonstrate a moderate decrease of complexity and a loss of information in the system some time before the epileptic seizure. This can be seen also in the period immediately after the seizure, as well as during the above mentioned short paroxysms without seizure when mild derangement of skills or transitory cognitive impairment occurred [37,38] without loss of consciousness.

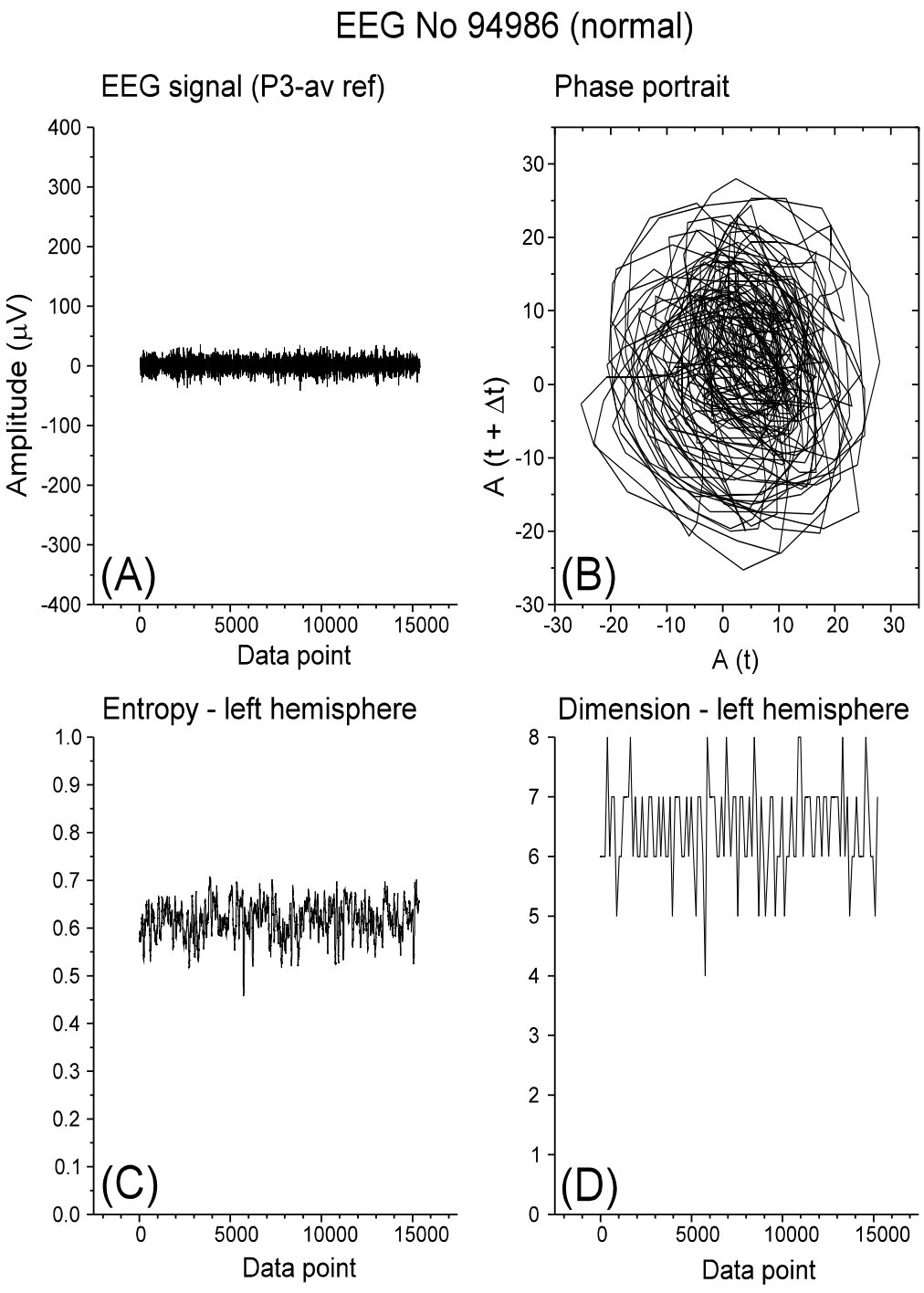

Figure 10 Normal EEG signal of a 6-year-old child.

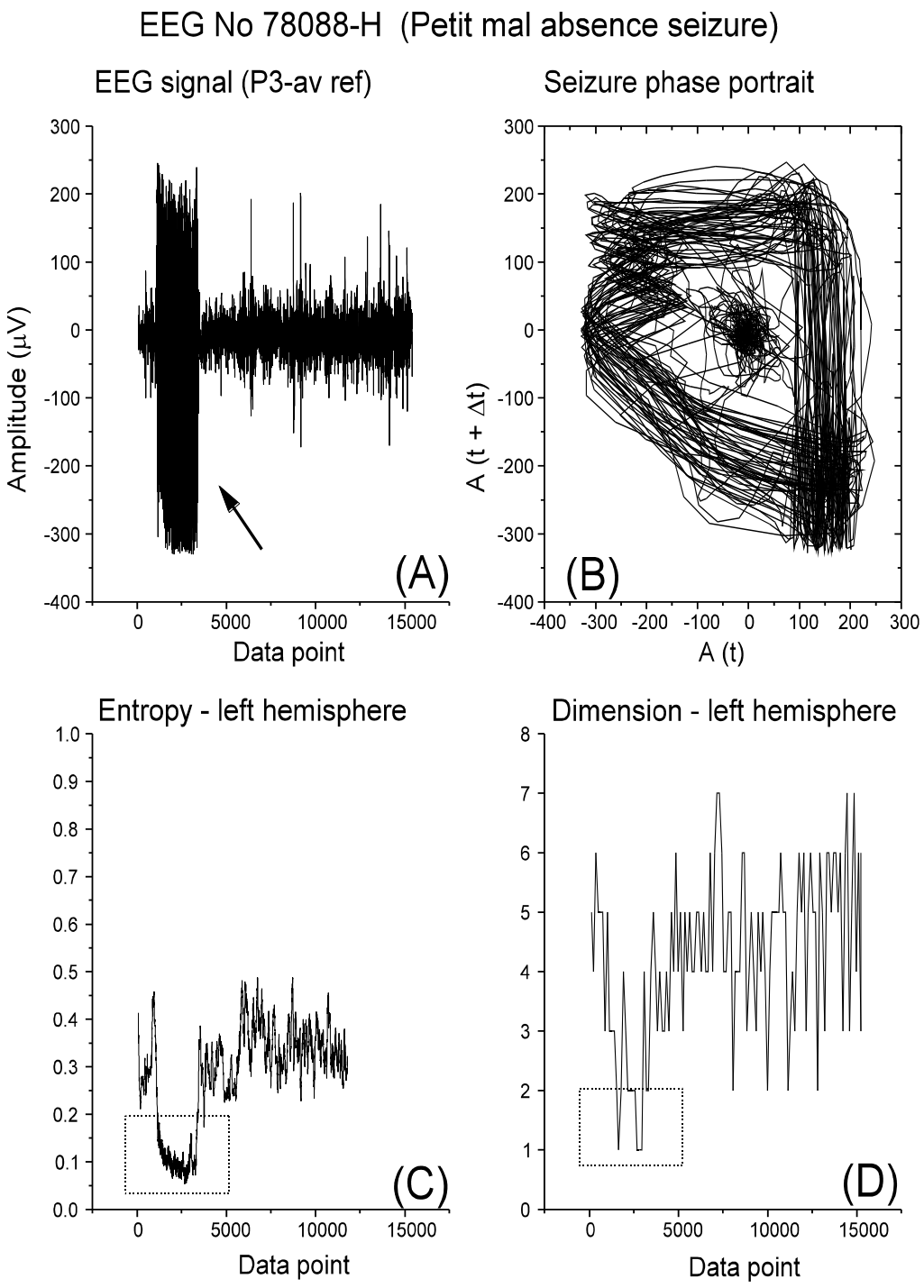

Figure 11 EEG signal during epileptic seizure (petit mal absence) in a 6-year-old child.

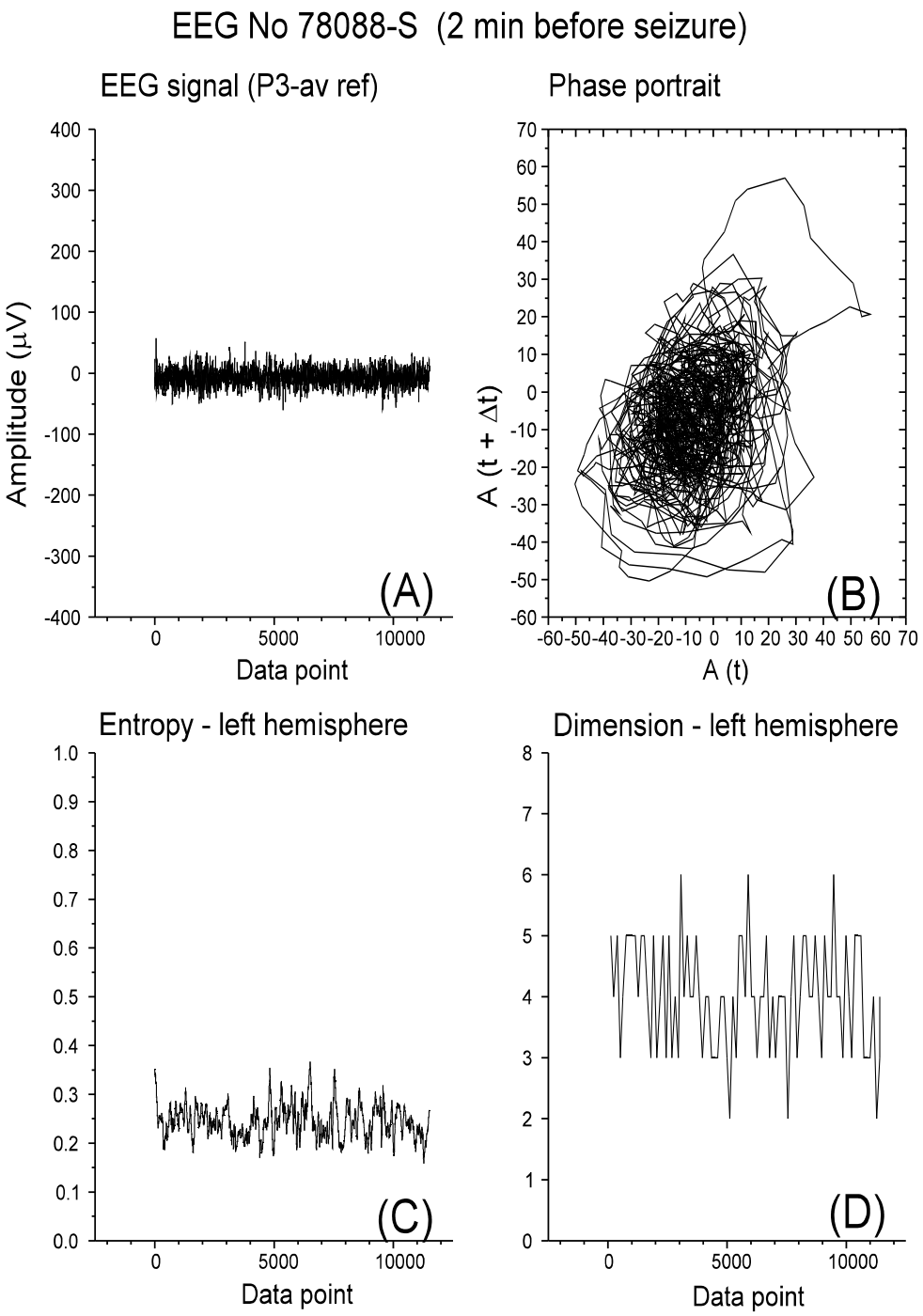

Figure 12 EEG signal recorded 2 minutes before the seizure.

In our examples we showed a correspondence between the degree of chaoticity of brain electrical function and the status of consciousness and cognition: a lesser degree of decrease of complexity (decrease of the chaoticity, transition to more orderly regime of work and consecutive theoretical loss of information) corresponds to cognitive impairment, while a greater degree corresponds to a deeper disturbance of consciousness during the epileptic seizure.

5. CONCLUSION

In order to interpret the results obtained by the application of the theory of deterministic chaos in EEG analysis, we must first answer the following questions:

- Is it possible to identify the attractors for different states of brain activity and to describe them by deterministic dynamics?
- Do these results tell us anything?
- Do they tell us anything we didn't already know?
- Do they tell us anything useful?

Based on our current knowledge and results, we think that the answers to all these questions are affirmative. Indeed, some states of brain activity can be differentiated based on deterministic chaos measures. New complexity measures (entropy and dimension) define the system in a distinctly different, deterministic way. For the time being, there is a close correspondence between the deterministic dynamics of brain electrical activity and states of consciousness and cognition.

Speaking in general terms, it seems that the principle of organization of biological systems in the form of highly complex non-linear processes, whose activity fluctuates on a broad-range scale, enables its *functional adaptation* (plasticity). Work fixed in one mode, i.e., periodic motion, is opposite to this requirement of functional responsiveness, and it was exactly this type of low-complexity behavior that we saw in pathological cases. It seems that biological control mechanisms actually *drive the system away from the steady state.* This standpoint is opposed to classical medical theory of homeostasis, according to which stable physiological processes tend to maintain "constancy". Contemporary theory of biological systems obviously needs to be revisited and extended to account for those types of far from the equilibrium behaviors described during the last decade.

There is much more that needs to be done to confirm the present results and to widen their application to the research of the consciousness and cognition. Nevertheless, it can be said that the theory of deterministic chaos has found its place in the elucidation of the dynamics of brain functions that underlie psychic processes.

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ON METHODOLOGY OF EEG ANALYSIS DURING ALTERED STATES OF CONSCIOUSNESS

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If the doors of perception were cleansed
every thing would appear to man as it is,
infinite.

(William Blake)

Abstract. Altered states of consciousness exhibit subtle EEG changes that must be observed with carefully chosen methodology and signal processing procedures. Generalized psycho-physiological model of the Self is introduced to point out the possible sources of nervous system excitation that are particularly important in altered states of consciousness. The proposed methodology is based on a combination of static (artifact-free EEG) and dynamic analysis to characterize underlying neurophysiological states. We developed an open software environment **STATE** (**S**patio-**T**emporal EEG **A**lteration **T**racing **E**nvironment) to support this methodology and provide support for signal processing functions and efficient visualization procedures. Proposed methodology and software environment are used for analysis of brain activities during altered state of consciousness related to the healing process. We present here obtained results and new parameters in quantitative EEG analysis that can be efficiently used to characterize state of consciousness.

Keywords: *EEG, methodology, consciousness, signal processing, envelope, healing.*

1. INTRODUCTION

At the end of 20th century, contemporary science considers itself capable to cope with the ultimate secret of Nature - consciousness. Philosophers, psychologists, neurophysiologysts, physicist, engineers and other scientists investigate the problem from their own point of view, like shadows on their wall of Plato's cave, but the answer must be one and unique, as consciousness itself. How can we use EEG, as a crude measure of temporal activity of 10^{10} neurons, to study such a subtle pheno-

menon? To paraphrase gestalt psychologist Kurt Goldstein, if consciousness appears on points of contact between organism and environment, then EEG and MEG might be the tools of choice.

The relation between EEG and gross neurophysiological changes in different states of consciousness (alertness vs. sleep, sleep phases, coma, epileptic seizures, etc.) is well established and analyzed [1-4]. The situation is somewhat vague for subtle changes, but we believe that every subtle change generates evident physical equivalent (and vice versa). Altered states of consciousness as extreme cases are indispensable in studying the nature of consciousness.

Two basic approaches to the analysis and modeling of consciousness are applied. Successful neural network models of parts of neural system inspired so called "connectionists" approach that led to the conclusion that consciousness is "in fact no more than behavior of a vast assembly of nerve cells and their associated molecules" [5]. However, the largest problem with this approach is still an explanation how brain integrates fragments of information derived from highly specialized set of neurons to create unity of perception and thought. This problem is called *binding problem*. The above approach can hardly explain how we can perceive gestalts from a large amount of sensory information almost instantly.

The second approach is based on neural fields. In this model, the electromagnetic field of brain activity *binds* together particular parts of information [6-10]. Brain wave patterns therefore represent internal language of the brain and create local resonance (see Adey, John, Başar, and Leinfellner in [4]). Strong support for this approach is derived from the theory of coupled oscillators and spontaneous synchronization of biological systems [11]. Deterministic chaos has been frequently used in explaining brain dynamics through the last decade. Moreover, chaotic systems are capable of producing novel activity patterns. That feature may influence brain's creativity and trial-and-error problem solving.

We believe that certain pattern(s) of EM field activity represent the basis from which different states of consciousness arise. Our hypothesis is that those patterns, although subtle, could be detected in brain electrical activity. In this paper, we present framework of analysis that could be used to characterize subtle EEG changes.

2. GENERIC MODEL

Although it was not perfectly clear what consciousness is, we will try to use engineering approach to the problem using "black box" model of the *Self* as a conscious entity. Fig. 1 depicts generalized psycho-physiological model of the *Self*. It consists of three major blocks:

(1) *Perception* is input block, which process sensory inputs (vision, sound, touch, ...).

(2) *Action* generates different outputs (thoughts, emotions, physical actions, ...)

(3) *Conscious processing* block interacts with both blocks and influences their activity according to the genetic heritage and the history of processing (sequence of inputs and action feedback representing experience). Some of its functions are simple connections between neurons (reflexes for example), and some emerge as complex interactions.

In spite of the fact that model of such simplicity must have high complexity elements (in this case *conscious processing* block), it can point out very important aspects of system functionality.

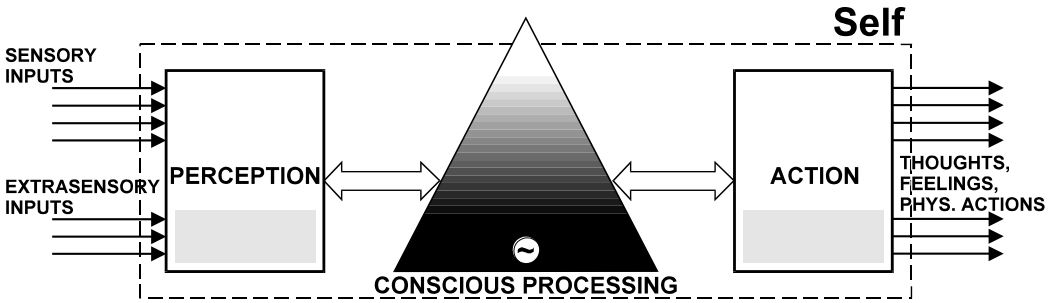

Figure 1 Generalized psycho-physiological model of the *Self*.

Extreme states of consciousness are mostly related to the modified functionality of *Perception* block. Its output is changed by overloading senses, sensory deprivation or by changing its functionality (drug admission for example) [12]. Having in mind that during these states *Action* block exhibits rather altered output than its cessation, we can draw a conclusion that our model must have either internal generator or set of inputs that is not dependent on senses. We will introduce both possibilities in our model:

(1) *Internal signal generators* within the *Conscious processing* block, represented as a white circle.
(2) *Extrasensory inputs* as a means of communication with environment. They are represented as a set of separated inputs coming to the shaded part of *Perception* block.

Internal signal generators are set of physiological control loops within the organism, such as heart or breath control loops. Their fields influence significantly course of conscious processing, but their function is also influenced by the overall conscious state. The breath control loop is exceptionally important as it can be easily consciously controlled. It was shown that a mixture of combined yogic practices of

breathing and relaxation (Santhi Kriya) increased alpha activity both in occipital and pre-frontal areas of the brain denoting an increase of calmness [13].

Extrasensory inputs may help in explaining most of psychic phenomena [14]. If electromagnetic (EM) field plays crucial role in explaining higher functions of conscious processing, then inter-personal influence of particular EM field must be taken into account. One can argue that the intensity of such field is negligible to induce any action. However, we should have in mind that basic processes within the brain are based on resonance [10], and that even slow intensity field may "provoke" resonant patterns of activity [15]. Framework for this analysis is given through the theoretical model of Dejan Raković [16-19].

Throughout our research we have been looking for a *scientific* evidence of both generators in our model, and characterization of their influence on consciousness. We believe that answers to these questions may offer clues for understanding the very nature of consciousness.

3. EEG CHANGES DURING ALTERED STATE OF CONSCIOUSNESS

According to the generic model and framework of our investigation we will pay our attention particularly to a conscious change of state of consciousness and inter-personal interactions. The most prominent examples of the first kind are meditation, relaxation, and similar techniques, and the healing process presents the most significant example of the second kind. We investigated inter-personal interactions through the healing process, as a particularly intense conscious effort to establish inter-personal communication and help the patient [20-21].

Most of research associated with the changes in brain electrical activity (BEA) in altered state of consciousness is related to meditation [22-29]. The most important features of EEG changes related to meditation are:

(a) Establishing α–activity in spite of open eyes (Hirai [22]);

(b) Increased amplitude of α–activity (Hirai [22], Banquet [23,24], Wallace [25]);

(c) Slower frequency of α–rhythm (Hirai [22], Banquet [23,24], Wallace [25];

(d) Rhythmical θ–waves (Hirai [22], Banquet [23,24], Wallace [25];

(e) Increased synchronization (*hypersynchronization* - Banquet [23,24]);

(f) Dissociation of perception from the external sense organs (Hirai [22], Ray [27]);

(g) Transcendent signal (Ray [27,28]);

(h) Occasional fast wave β– and γ–activity (Banquet [24], Das and Gastaut [25], and Ray [27]).

The first four changes are reported during the study of EEG changes related to Zen meditation [22]. Kasamatsu and Hirai ranked the changes in this order and found out that the changes directly depend on mental state and experience in meditation. During zazen (Zen meditation) alpha was slowing to 7-8 Hz, and rhythmical theta waves at six to seven cycles per second appeared in the last phase (attained only by skilled monks with long meditation experience).

In addition to the standard frequency bands, Ray has found so called "focused arousal" frequency component at 38 Hz. This frequency component was found during the *Dharana* stage of *Rajayoga* [26]. Ray supposed that it could represent a possible functional component in the process of attention (*Dharana* means holding the mind at a certain point).

Changed perception during meditation is frequently reported. Subjects usually define it as relaxed awareness with stable reception. We define this state as dissociation of perception from the external sense organs. Quantitative investigation of this phenomenon is performed by Hirai, and alpha block dehabituation was found [22].

A particularly hard problem is analysis of *transcendent signal*. Ray defined it as a signal that is not bound to the time frame by any law of time domain [26]. He investigated transcendent signal in relation to the highly amused states of a child as well as state of deep aesthetic appreciation [27]. However, the transcendency is likely to be correlated with the clock of the organic system. These states are characterized by large number of impulses (spikes), and increased low frequency waves (theta and specially delta waves).

Fast wave activity was occasionally reported [24,25,27]. Banquet identified synchronous beta waves from all brain regions of almost constant frequency and amplitude [24]. That activity was found at four advanced meditants during the subjectively reported deepest meditation. Das and Gastaut performed electroencephalographic examination of seven yogis and observed that as the meditation progressed the alpha waves gave way to fast-wave activity at the rate of 40-45 Hz, and that these waves subsided with a return of the slow alpha and theta waves [25]. Ray has found unusually large activity in the frequency range 16-18 Hz, during highly amused states as well as state of deep aesthetic appreciation [27].

To the best of our knowledge EEG changes related to the healing process are rarely investigated. Zhang reported the EEG alpha activity during the Qi Gong state that occurred predominantly in the anterior regions [29]. The peak frequency of EEG alpha rhythm was slower than the resting state, and the change of EEG during Qi Gong between anterior and posterior half had negative correlation. It can be seen that reported changes are very similar to the previously described changes during the meditation.

4. PROPOSED METHODOLOGY

We propose a methodology of characterizing certain neurophysiological states by tracing characteristic spatio-temporal patterns of EEG activities, as depicted in Fig. 2.

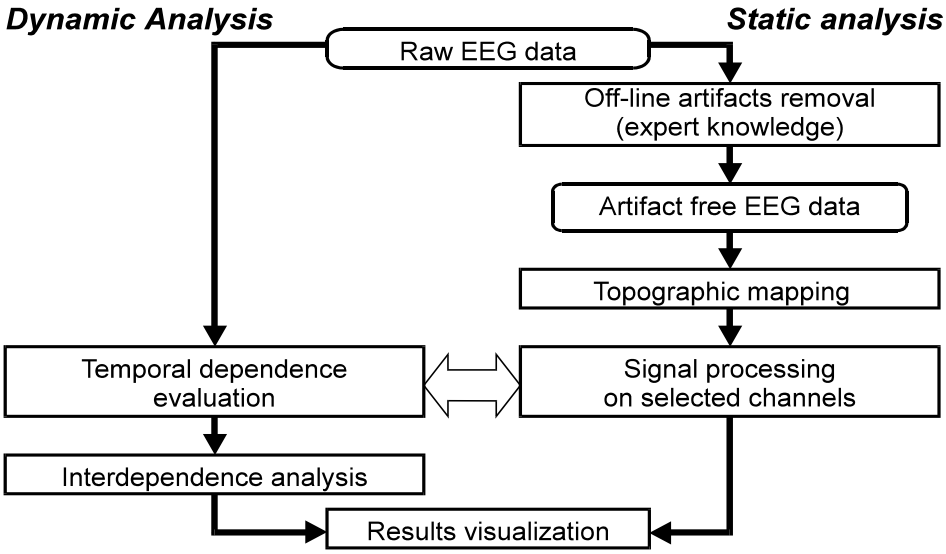

Figure 2 Block diagram of adopted methodology.

The analysis is divided in two parts: *static* and *dynamic*.

(1) *Static analysis* uses artifact-free EEG to characterize long-term (average) activity. However, by removing signal sections with artifacts we lose temporal information as well.
(2) *Dynamic analysis* is performed on original signal to trace temporal patterns of activities as well as short-term changes in brain activities.

The analysis starts by expert's off-line manual artifact removing. In spite of some promising results in automatic artifact removal, manual removing using expert's knowledge is still preferred method in analysis. Then, topographic maps of artifact-free signal are built to indicate channels that have dominant activity in certain frequency bands (delta, theta, alpha, beta, etc.). The most interesting EEG channels are used in further signal processing procedures (spectral, coherence, wavelet, chaos and other analyses).

Then, on selected channels we perform dynamic analysis by constructing graphs with temporal dependencies on the parameters selected (spectrogram, dominant band frequency, animation of topographic maps, coherence, ...).

Further on, dynamic analysis can indicate time intervals with significant changes of basic parameters (mean frequency, intensity, etc.), which are then subjected to additional static analysis. According to our experience this interaction between static and dynamic analysis yields the best characterization of underlying neurophysiological changes.

In addition, interdependence analysis provides subtle information on simultaneous changes in brain electrical activity recorded from two subjects in the interactive state of mind.

Although the frequency domain analysis represents indispensable signal analysis procedure, we have found very useful time-domain analysis on different frequency band limited signals. It emphasizes both short-time signal changes, as well as statistical properties of the signal.

Certain frequency bands may indicate activity on different hierarchical levels, as depicted in Table 1. Source of activity in gamma, beta and alpha frequency band is thoroughly investigated, and we introduce hypothetical framework of analysis for the activity in theta, delta and sub-delta bands. Our hypothesis follows direction of the higher three bands that *lower frequency represents higher level of integration, i.e. information binding*. Therefore, activation in certain frequency band may indicate activity on the equivalent consciousness level. The proposed scheme may correspond with Jung's structure "ego-consciousness-individual unconsciousness-collective unconsciousness".

Table 1 Possible sources of activity in certain EEG frequency bands

Frequency band	**Activity**
Gamma (γ)	Individual neurons
Beta (β)	Specialized regions
Alpha (α)	Physical consciousness
Theta (θ)	Mental consciousness
Delta (δ)	Higher level of consciousness
sub - Delta	Collective consciousness

5. BASIC CHARACTERISTICS OF THE ENVIRONMENT

In spite of extensive support for standard EEG signal processing, existing software packages do not provide enough flexibility for studying subtle EEG changes. Therefore, we decided to develop our open software environment for at least two reasons: a) total control of procedure parameters, and b) the possibility to develop original and improve existing signal processing algorithms.

Our open software environment is called **STATE** (**S**patio-**T**emporal EEG **A**lteration **T**racing **E**nvironment) [30-31]. Although it was primary designed to provide support for signal processing functions, a great deal of efforts was spent to make efficient visualization procedures and methods. The realized software environment was developed to support proposed methodology of tracing subtle EEG changes.

The STATE software package is an interactive open environment, developed under Windows 3.11. Most procedures are executed using MATLAB 4.0 [33], and some procedures are developed in C language and integrated in the environment. Procedures provide the following support (for more details see [30-32]):

- Spectral and correlation analysis of EEG (with optional removing of artifacts). For epoch length and introduced considerations see [31, 34,35]
- Spectrogram analysis
- Cepstrum analysis
- Topographic mapping (for details see [36]) of various parameters such as:
    - absolute and relative power in frequency bands
    - power ratios between bands
    - z-score values
    - coherence
- Monitoring of temporal changes of relevant spatial characteristics (cross-correlation values, animation of topographic maps, instantaneous envelope and frequency, amplitude and frequency modulation index, ...)
- Wavelet analysis (decomposition on the wavelet orthonormal basis using different types of filters)
- Deterministic chaos analysis (the correlation dimension of strange attractors)

Time domain analysis makes use of different signal processing techniques for the extraction of instantaneous envelope and phase of EEG signal [37]. The instantaneous envelope is proportional to the instantaneous root mean square value of the signal, and therefore the energy of a certain frequency band could be traced in time.

The EEG signal could be analysed as both amplitude and frequency modulated [37]. This type of analysis was used to quantify alpha modulation in relation to cerebral blood flow [38], but we have found it very useful to quantify EEG changes in both subjects during the healing session.

The most important signal parameters for characterizing altered states of consciousness in time-domain analysis are:

- Histogram of temporal channel activation (based on current envelope value)
- Signal envelope periodicity
- Instantaneous frequency of certain frequency band
- Band power peak to peak interval [39]
- Amplitude modulation index
- Frequency modulation index

5.1 Experimental set-up

We performed recordings in electromagnetically shielded room (Faraday cage) on 18 channel EEG machine MEDELEC 1A97, and obtained 16 channel EEG with common (average) reference. Electrode positions were adopted according to International 10-20 System: F7, F8, T3, T4, T5, T6, Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2. We used Ag/AgCl electrodes, with impedance less than 5 kΩ. Bandpass filter was set to 0.5-30 Hz, and power supply notch filter was not used. For AD conversion we used PC AT with ADC board Data Translation 2801 (16 channel) with the sampling frequency of 128 Hz. Software for standard topographic (off-line) EEG analysis was RHYTHM V.8.0 from Stellate Systems Inc., Quebec, Canada. For spectral analysis we used 20-seconds segments of EEG data with optional off-line manual artifact removal.

EEG was recorded separately from two adult human subjects (healer and patient-healee), before, during and after the healing session for 120 seconds in each period. Patient was in relaxed state with eyes closed. Healer kept eyes closed and had no activity apart from mental effort. Subjects had no physical contact.

During the healing session the healer had stable basic physiological parameters: heartbeat rate (72 beats per minute), breath (4–5 per minute) and almost ceased eye movements.

6. RESULTS OF ANALYSIS

The analysis on brain electrical activity changes led to the following conclusions:

(a) Healer's brain electrical activity showed shift in power spectrum toward slow frequencies (most pronounced in delta and theta range as illustrated in Fig. 3) during the session, compared to periods before and after it. Spatial distribution of changes was dominant over frontal and anterior temporal regions, and symmetrical. This change is not usual correlate (in absence of drowsiness) of intense mental effort [3].

(b) Decrease of alpha activity, and increase of maximum alpha frequency during and immediately after the healing session (see Figs. 4 and 5). Both characteristics differ significantly from the meditation-based state of consciousness [22-25].

(c) Reduced number of discrete frequency components, representing stabilization of electrical activity in frequency domain.

Coherence of BEA from homologue left and right regions (8 pairs of electrodes), as a measure of functional coupling, showed profound changes in its pattern. Coherence of prefrontal and frontolateral region's BEA [3] (F7/F8, Fp1/Fp2) was significantly increased in delta and theta range during the session, and return to pre-session values only in F7/F8 channels. Frontal parasagital region (F3/F4) conversely showed the coherence increases only after the session and only in theta range. These patterns of cortical functional organization that occurred during defined time intervals clearly differ from one another, indicating characteristic brain regional activation/deactivation during specific tasks.

(e) The pattern of spatial activity found in healer's EEG was similarly induced in patient's EEG during the session.

(f) Subject's (healee) report on behavioral changes during the session indicated that there were rhythmical changes in his jaw muscle tone, with approximate frequency bellow 1 Hz. EEG changes that could correspond to this phenomenon are often excluded in analysis implementing conventional methods, but our envelope analysis of some frequency bands indicates possible confirmations for such changes. We suggest further exploration of these low-frequency phenomena.

(g) Significant stabilization of instant frequency in lower frequency bands, as depicted in Fig. 6.

(h) Stabilization of energy fluctuation at lower frequencies, according to envelope changes (see Fig. 7). Temporal envelope changes during the healing session and after it are shown. Increase of mean power in delta band should be observed.

(i) Occasional patterns of synchronous change in signal modulation as presented in Fig. 8.

(j) Stable modulation of delta frequency band with approximately five seconds period.

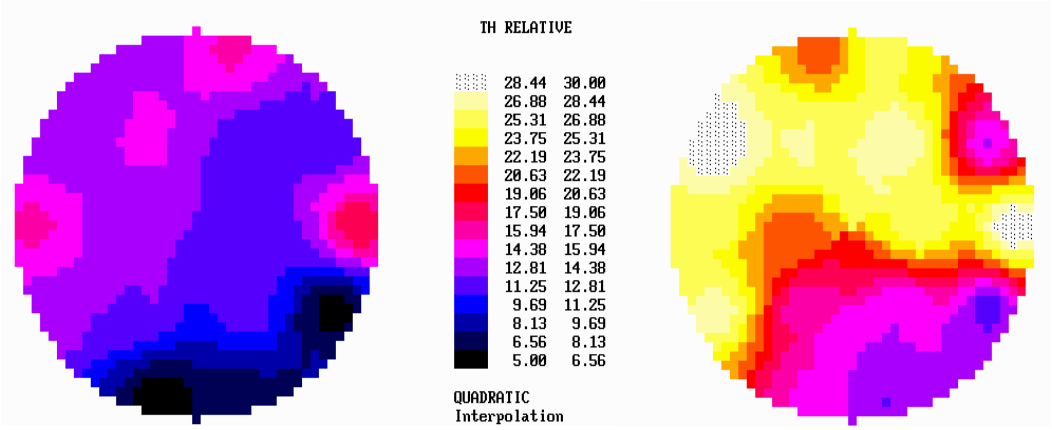

Figure 3 Topographic maps of 20 seconds of artifact-free healers EEG in theta frequency band before (left) and during the healing session (right).

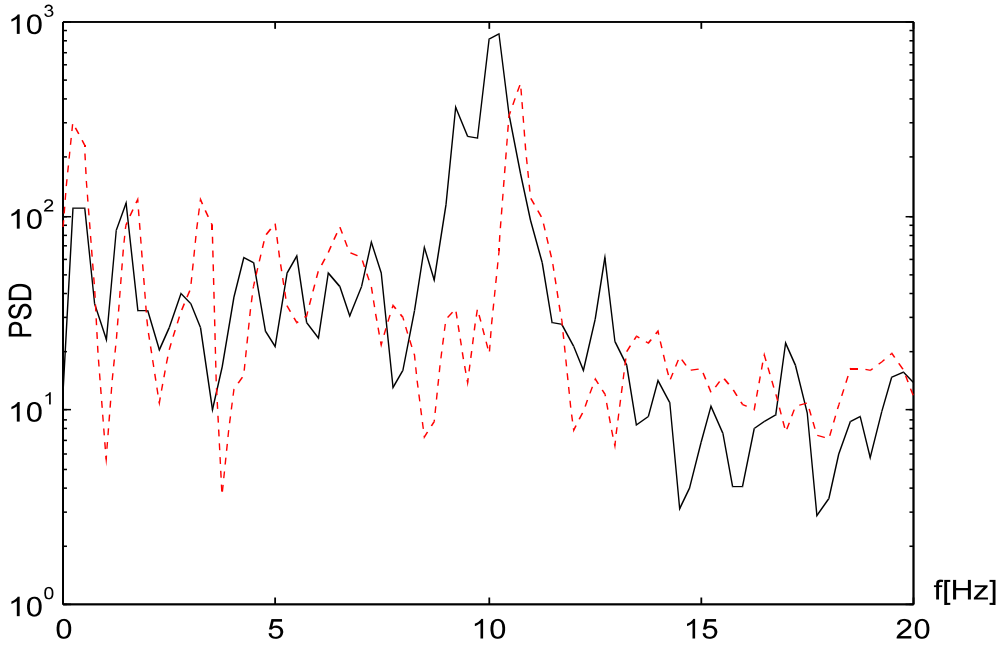

Figure 4 Spectral power of healer's channel F3 before (solid line) and during the healing session (dashed line); Artifact free sections; Session time, 80-100 s.

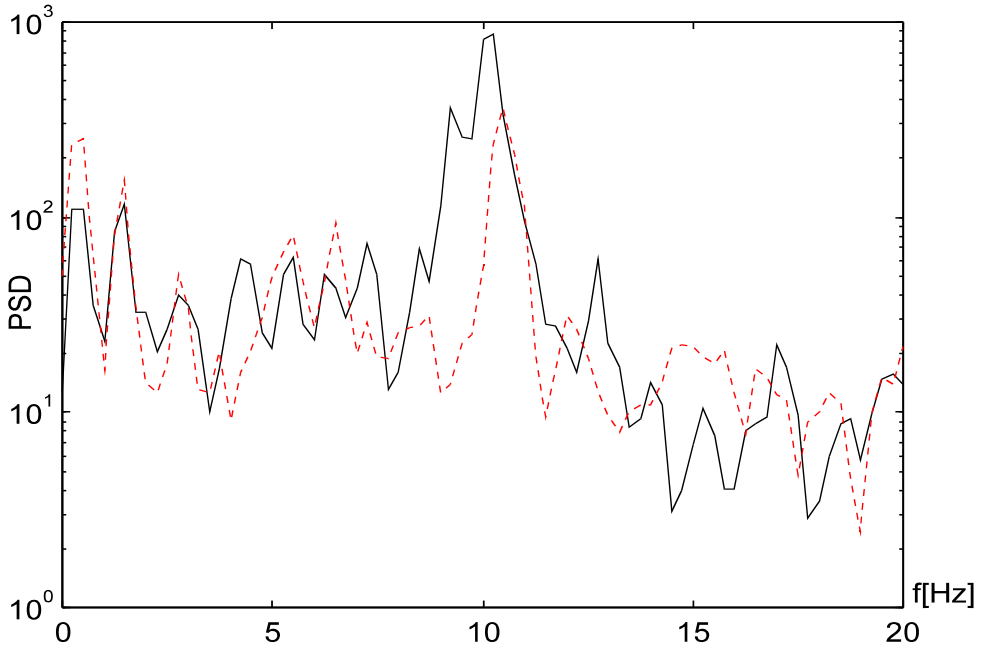

Figure 5 Spectral power of healer's channel F3 before (solid line) and immediately after the healing session (dashed line); Artifact free sections.

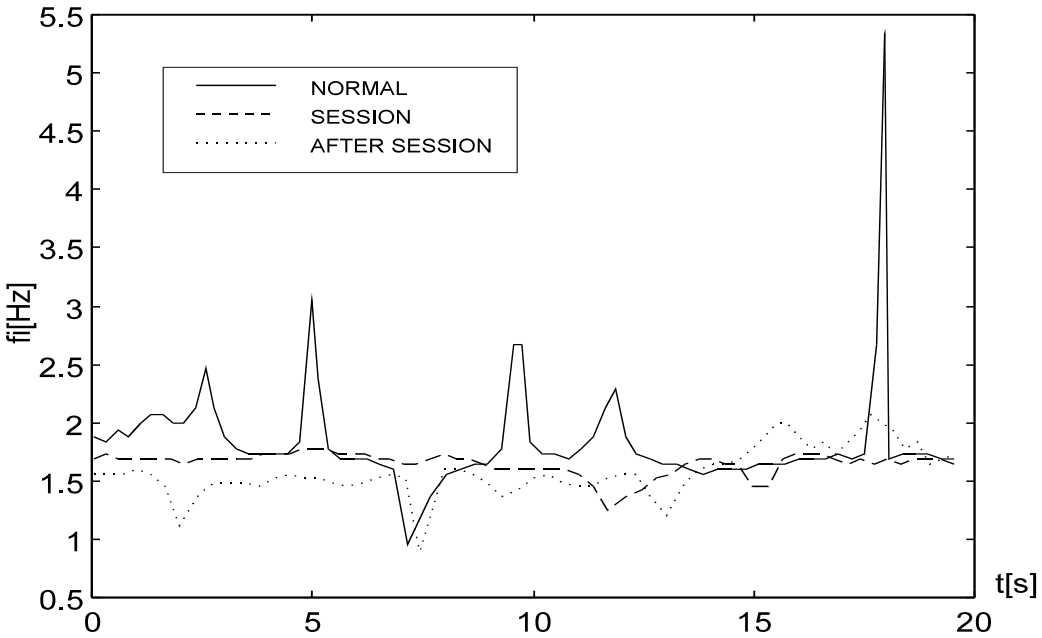

Figure 6 Instantaneous frequency of bandpassed filtered delta (1.5-2Hz) before (solid line), during (dashed line) and after the healing session (dotted line); Artifact free sections; Session time 80-100 s; Channel F3.

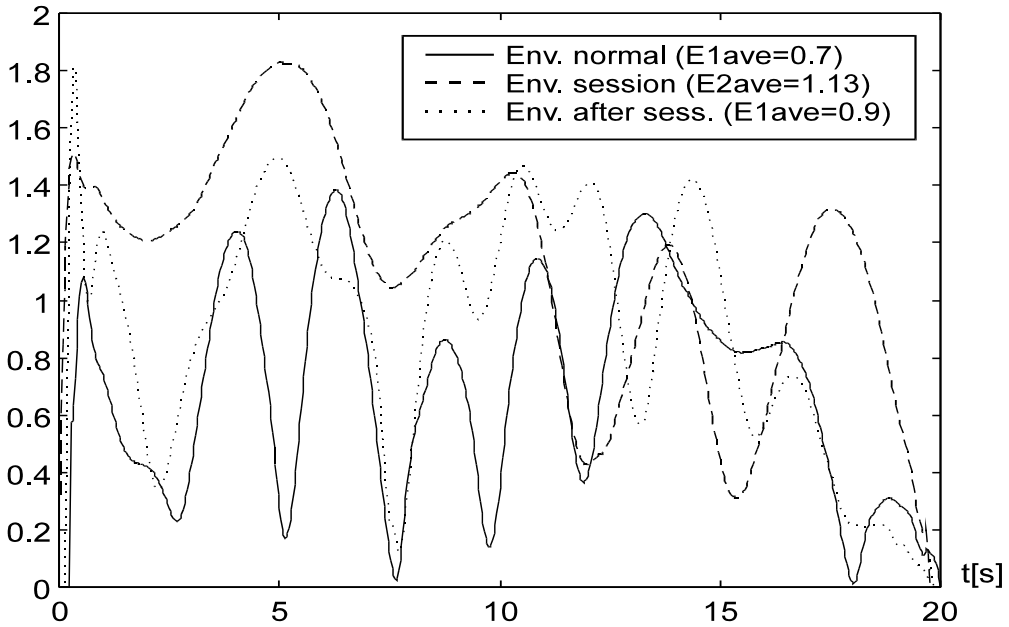

Figure 7 Envelope of bandpassed filtered delta (1.5-2Hz) before (solid line), during (dashed line) and after the healing (dotted line) session; Artifact free sections; Session time, 80-100 s; Channel F3.

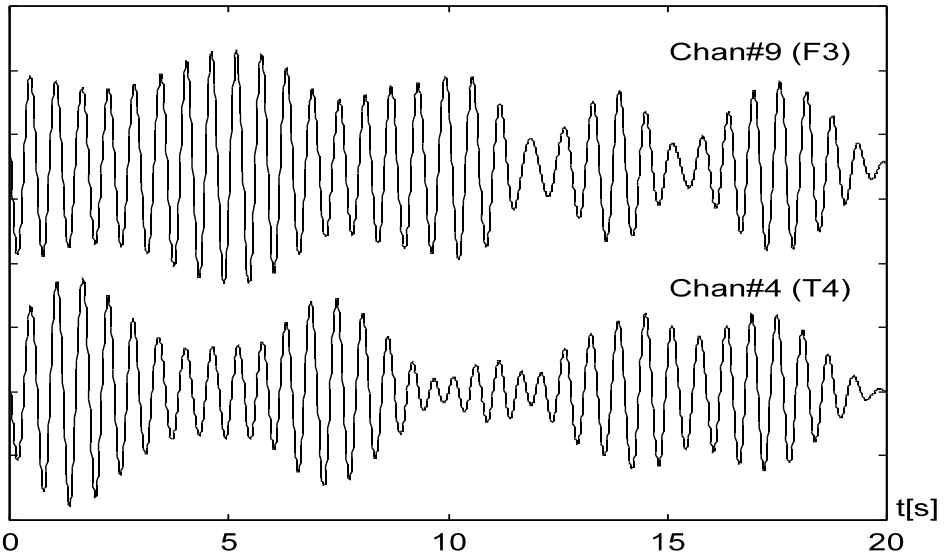

Figure 8 Synchronous spatial change of bandpassed filtered delta envelope (1.5-2 Hz) during the healing session; Channels F3 and T4; Artifact free sections; Session time, 80-100 s.

7. CONCLUSION

Studying states of consciousness requires a carefully chosen methodology and subtle processing and visualization procedures. Robust long term analysis inherently omits short-period analysis in brain activity. Moreover, care should be taken to avoid disclosing significant changes as artifacts. Therefore we suggest carefully chosen methodology as a combination of static and dynamic analysis, and "marking" instead of disclosing artifact-like changes. The proposed methodology and developed software environment (**STATE**) were used to analyze neuropsychological changes during healing session.

We have found that EEG changes during healing session provide significant base for the analysis of altered state of consciousness, as well as non-sensory interactions. Naturally, it is not easy to find right subjects for the experiments, but we have found few subjects that exhibit statistically significant changes.

The analysis emphasized significance of tracing spatio-temporal EEG changes, and particularly temporal tracing of signal modulation parameters. It was shown that this approach points out some very low frequency changes (bellow 1 Hz), that would be otherwise missed using standard computerized EEG analysis.

Further investigation will be directed toward selecting the most significant statistical parameters within the larger set of experiments, and precise quantification of interdependence correlates.

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IN SEARCH FOR A NEW PARADIGM

Information physics: In search of a scientific basis of consciousness
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The universal consciousness and the universal code
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INFORMATION PHYSICS: IN SEARCH OF A SCIENTIFIC BASIS OF CONSCIOUSNESS

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Abstract. In this paper we consider a scientific interdisciplinary approach to consciousness. Molecular computing, both quantum and classical, has been used as a link between physics and biology. However, connections between biology and consciousness, and consciousness and physics can be explained through a new physical theory - *information physics*. The information physics we propose encounters a synergetic theory of classical mechanics, quantum mechanics and theory of information. Using information physics, as a new scientific paradigm, we have found that microtubules, clathrins and water clusters in living cells are major bimolecular devices which satisfy synergy principles of classical mechanics, quantum mechanics and information theory. Based on information physics we propose that human sub-consciousness has its beginnings in microtubule-water clusters interaction inside of the tube. Through a hierarchy of cytoskeleton network of cell and neural networks activities on synapses becomes consciousness, while in the brain synergetic activities result in self-consciousness. Our model of human consciousness can be tested on both levels molecular, as a general anesthesia experiment, and brain, through mapping conscious contents of the brain into artificial devices. This device has to be self-assembled on the same principles of information physics, which we have used to explain human consciousness.

Keywords: *quantum mechanics, chaos, fractals, Cantor random set, golden mean, information physics, microtubules, clathrin, water, sub-consciousness, consciousness, self-consciousness*

1. INTRODUCTION

Consciousness is a common thing but is too mysterious to understand indeed. This is a longlasting paradox and calls for scientific investigation. As Einstein said, "The most beautiful thing we can experience is the mysterious. It is the source of all true art and science". It can be said, according to Einstein, that scientific research without mysterious note may result in only local scientific truth. However, results based on local truths are useful for everyday life. For example, we use statement like "... the sun arises in the east and sets in the west", because this "fact" determines our

everyday behavior and experience. One of the main reason for this kind of vision is, that we stay on the Earth without sensing that it rotates. Similarly, most of our scientific truths are local ones because we do not include in our approaches consideration of consciousness. Quantum mechanics is one of the first mysterious scientific discipline which covers this problem as a human being-experiment interaction. But in quantum theory, which has more faces, there are (Dirac approach) at least four troubles ("ghosts"): gauge invariance, the fine structure constant, the singularities and the negative energies. For this reason, the relation between local scientific truths and quantum mechanics is similar as the muses position in mysterious ancient mythical world: "We know how to speak of many a lie so akin to truth, but when we so wish, we do know how to speak up the very truth". Local scientific truths look like "many a lie so akin to truth", while quantum mechanics looks like "when we so wish, we do know how to speak up the very truth". In goal to search quantum mechanics' " so wish to speak up the very truth", we propose to overcome some confusion about quantum theory and use its ontological rather than epistemilogical interpretation. This allows us to propose information physics as a new physical theory.

2. FUNDAMENTALS OF INFORMATION PHYSICS

2.1 Information theories and physics

In information theories coding is one of the crucial points to define information. Shannon's famous theorem gives us one possible solution which has been exploited in human-made information systems with great success. The basic idea is simple: given a data source which emits letters L_1, L_2 , L_3, ... L_n with probabilities p_1, p_2, p_3, ... p_n respectively, each letter emitted being chosen independently of all other symbols, there exists a binary code which gives the best data compression. Bearing in mind that data compression is one of the fundamental questions in communication theory, it is understandable why Shannon's noiseless coding theorem has been so popular in classical communications engineering approach. However, success in the application of this technical approach to the theory of information on biological systems was partial. One of the main reasons for this is quite different biological solutions: self-organization and self-control of living matter versus bulk matter and system controlling from outside.

According to Shannon's coding theorem we can always reliably distinguish between different letters (or symbols). Different symbols mean different states of a physical carrier of information. If the physical carrier of information is macroscopic, Shannons theorem works well, while for quantum mechanical systems it needs to be reformulated. Why do quantum systems make a difference? In quantum systems the

physical bit is any quantum object for which the state is described by a vector in two-dimensional Hillbert space. For these systems quantum mechanics states that only states represented by mutually perpendicular vectors can be perfectly distinguished from each other. If symbols-states are non-perpendicular, which is usually the case, any deduction procedure is imperfect. For the link between classical mechanics and quantum mechanics the important question is: which N-dimensional Euclidian space of coding will give 90^o angle between the vector pointed from the origin (0, 0, ... 0) to the point (1, 1, ... 1) - and any coordinate axis? If that one Euclidian space (macroscopic) of coding exist, then correct mapping of information contents between it and quantum systems can exist. In the search for this kind of Euclidian space, we will consider the problem of unit spheres as the most perfect symmetrical object.

2.2 Unit spheres

To define N-dimensional Euclidean space it is necessary to use Pythagorean distance as

$$X_1^2 + X_2^2 + X_3^2 + \mathsf{L} \; + X_n^2 = r^2, \tag{1}$$

which is equal to the definition a sphere of radius "r" by this expression. It is well known that the formula for the volume of a sphere is

$$V_n(r) = C_n r^n, \tag{2}$$

where C_n is a constant (unit sphere):

$$C_n = (2\pi/n) C_{n-2}. \tag{3}$$

To find the values of C_n it is necessary to use a gamma function and its integral in polar coordinates [1]. Calculations based on Eq. (3) and symmetry gives results [2,3] which are summarized in Table 1.

From Table 1 we can see: (1) the volume of the unit sphere comes to a maximum at N = n = 5 and falls off to zero for N = n = ∞, and for N = -∞, (2) there is one-to-one correspondence between dimension (N) and dimensionality (n) for positive "N", while for negative one it is not the case, (3) in spate that negative dimensions (-N) exist there is only positive dimensionality (n), (4) negative dimensions (-N) are inversion of positive dimensions (+N) through dimension N = 0 , except for N = 1, (5) dimensionality of N = 0 is n = 3/2 (is not integer), and (6) there is a one-to-one correspondence between N(2), N(3), ... N(m) and N(-1), N(-2), ... N(-{m-1}) in N = 0, respectively. This gives result (Fig.1) that each pair,

including two infinities $+\infty$ and $-\infty$, has their unification in N = 0 (note that for N = 0, $V_0 = C_0 = 1 = 0!$ *zero factorial*).

Table 1 Information complementary for systems of all dimensions, based on symmetry and unit spheres.

$N = 6$	$C_6 = \frac{2\pi}{n} C_4 = \frac{2\pi}{6} \cdot \frac{\pi^2}{2} = \frac{\pi^3}{6} = 5.1677$
$N = 5$	$C_5 = \frac{2\pi}{n} C_3 = \frac{2\pi}{5} \cdot \frac{4\pi^2}{3} = \frac{8\pi^3}{15} = 5.2637$
$N = 4$	$C_4 = \frac{2\pi}{n} C_2 = \frac{2\pi}{4} \cdot \pi = \frac{\pi^2}{2} = 4.9348$
$N = 3$	$C_3 = \frac{2\pi}{n} C_1 = \frac{2\pi}{3} \cdot 2 = \frac{4\pi}{3} = 4.1887$
$N = 2$	$C_2 = \frac{2\pi}{n} C_0 = \frac{2\pi}{2} \cdot 1 = \pi = 3.1415$
$N = 1$	$C_1 = \frac{2\pi}{n} C_{-1} = \frac{2\pi}{1} \cdot \frac{1}{\pi} = 2 = 2$
$N = 0$	$C_0 = \frac{2\pi}{n} C_{-2} = \frac{2\pi}{\frac{3}{2}} \cdot \frac{1}{\frac{4\pi}{3}} = 1 = 1$
$N = \bar{1}$	$C_{-1} = \frac{2\pi}{n} C_{-3} = \frac{2\pi}{4} \cdot \frac{1}{\frac{\pi^2}{2}} = \frac{1}{\pi} = 0.3184$
$N = \bar{2}$	$C_{-2} = \frac{2\pi}{n} C_{-4} = \frac{2\pi}{5} \cdot \frac{1}{\frac{8\pi^2}{15}} = \frac{1}{\frac{4\pi}{3}} = 0.2387$
$N = \bar{3}$	$C_{-3} = \frac{2\pi}{n} C_{-5} = \frac{2\pi}{6} \cdot \frac{1}{\frac{\pi^3}{6}} = \frac{1}{\frac{\pi^2}{2}} = 0.203$
$N = \bar{4}$	$C_{-4} = \frac{2\pi}{n} C_{-6} = \frac{2\pi}{7} \cdot \frac{1}{\frac{16\pi^3}{105}} = \frac{1}{\frac{8\pi^2}{15}} = 0.1899$

If we consider the shell fraction of the volume of an N-dimensional sphere that is within a distance [d*] from the surface we can write:

$$\frac{\text{Shell}}{\text{Volume}} = \frac{C_n r^n - C_n\left(r - d^*\right)^n}{C_n r^n}. \qquad (4)$$

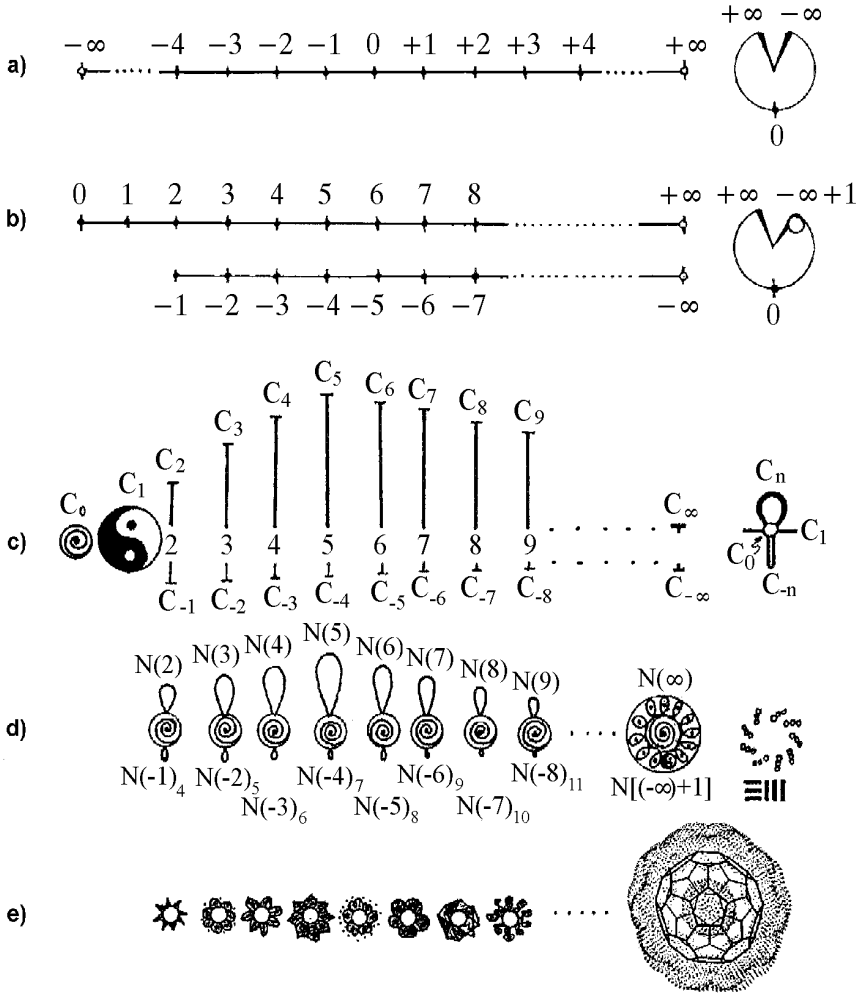

Figure 1 Cage networks as knot shells: a) Pure mathematical representation of positive and negative numbers and symbolic representation of infinities (+∞ and –∞); b) Positive and negative dimensions representation (Table 1). One member associates more with negative dimensions that positive; c) Unit sphere at zero (C_o) is present as Golden Mean spiral, while unit sphere of a one-dimension is present as two complementary units themselves. Other unit spheres of dimension N > 1 and N < 0 are complement through dimension N = 0. Maximal value of unit sphere is for N = 5. Symbolic representation of unit spheres of all dimensions is present too (right); d) Because dimensions N > 1 and N < 0 are complements in N = 0, their both point of departure and the end is in N = 0 (knots 0!); e) Possible representation of information objects as cage networks.

This is so for no matter how thin a shell we wish to use, and how close we wish to get to *value one. Now, if we examine the angle between the vector pointed from the origin (0, 0, 0, ..., 0) to the point (1, 1, 1, ..., 1) - and any coordinate axis, we will find that the projection on each axis is exactly equal to one. The length of the vector is $\sqrt{N}$, so the angle between diagonal line and each coordinate axis

$$\cos\alpha = \frac{1}{\sqrt{N}}. \qquad \textbf{(5)}$$

As we can see only for sufficiently large N ($N\to\infty$) angle α is $\pi/2$, or the diagonal line is perpendicular to each coordinate axis.

According to results from Table 1. systems with N > 1 can not exist independently, each of them has corespondent pair in N(-1), N(-2), ..., so that

$$R_W^N S_W^{(1-N)} = N(0), \qquad (6)$$

where: R_w is the real world (macro space-time: N(2), N(3), ... N(m)), and S_w we named the world of shadow (micro space-time: N(-1), N(-2), N(-3), ... N(-[m-1])). So, $N = \infty$ is orthogonal in N = 0, and may provide link between classical mechanics and quantum mechanics through coding in N = 0 as knot shall (cage network with value and properties of 0!).

2.3 Unit spheres packing and coding

Unit sphere packing in N-dimensional space is equal to coding and to digital transmission of information [4-6], where face-centered-cubic symmetry, as the symmetry group of the unit spheres packing, was used.

Results based on this research have shown that when packing is constructed from codes for digital transmission of information, dimensions N = 11, N = 12 and N = 13 are optimal for lattice packing, while dimensions N = 10 and N = 13 are optimal for non-lattice packing.

These results indicate that one possible information theory may exist based on the unit spheres packing. How unit spheres of positive and negative dimensions correlate to quantum mechanics is an open question, which we will consider using fractal space-time and renormalization quantum field theory approaches.

2.4 Information Physics

It was indicated that trajectorial behavior of quantum mechanics objects is characterized by a fractal [7]. A "thought experiment" was done, in which objects are confined to move on fractal space-time trajectories, treating the case of a Peano-

Moore trajectory in detail [8]. Also, it is known that chaos may generate stochasic and fractal behavior [9]. A connection between chaos and quantum, as "quantum chaos", was noted by research groups independently [10-13]. A disadvantage to these attempts was that quantum stochasticity had not been included in the quantum chaos theory. One approach to include the quantum stochasticity is called "chaos quantum" [9]. A major problem with chaos quantum has been its place in the theory of stochastic mechanisms of an "objective" background radiation ("noise") which have pervaded the Universe, giving every object of mass *m* a diffusion-type perturbation of intensity $\hbar/m$, where $\hbar$ is Plank's constant divided by 2π. This means that if one can smoothly transit fractal space-time (with Hausdorff dimension) to Minkowskian space-time (with Euclidean dimension) with random perturbation of source of mapping, it will be possible to unify classical mechanics and quantum mechanics. Our approach to solve this problem is through unification dimensions N = 0 and N = 1, what we named information physics.

To unify N = 0 and N = 1, an invariant set with the following properties has to exist: (1) the measure is zero; (2) the value is one; (3) the value of the transformation T(x) map of R_w (macro world) into S_w (micro world), and vice versa, has to be 3/2 (this is because for dimension N = 0 dimensionality is n = 3/2, Table 1.). If we use Cantor's random middle third set with $T(x) = (3/2)(1-|2x-1|)$ all our conditions are satisfied [14,15].

One of the most beautiful and sublime results in the last decade in mathematics is the Mauldin-Williams theorem, which shows that the Hausdorff dimension $D_H^{C(0)}$ of a randomly Cantor middle third set for N = 0 is $D_H^{C(0)} = GM^{-}$ or ϕ, where $GM^{-} = \left(\sqrt{5}-1\right)/2$ is the Golden Mean. If we extrapolate the random construction of the Cantor set to N dimensions with GM properties than the Hausdorff dimensions [16]:

$$D_H^{C(N)} = \left(1/D_H^{C(0)}\right)^{N-1}. \tag{7}$$

Based on Eq. (7), solution for $D_H^{C(4)} = 4 + D_H^{C(-2)}$ is $(1/GM)^3$ or $(GM)^{-3}$. In other words we can write Eq. (7) in form

$$D_H^{C(N)} = \left(D_H^{C(0)}\right)^{1-N}, \tag{8}$$

which is same as Eq. (6). If we summarize our calculation based on Eq. (8), Table 2, we see that the results are same as in Table 1.

We found that one of the main properties of dimension N = 0 is the Golden Mean (GM) based on random Cantor set. One more interesting question arises: what does n = 3/2 of N = 0 represent? To answer this question we need to consider our

system, in Table 1, from quantum mechanical point of view. It is well known from a quantum field theory [17] that the dimension of mass (D_m) is calculated from the expression:

$$D_m = (D/2) - 1, \tag{9}$$

where D is a space-time dimension value. Only for D = 5 (whose unit sphere C_5 is maximal in system) value of D_m is 3/2, what indicates: (1) mass is manifestation of N = 0 in 5-D space structure; (2) we see our world as 3-D (in spite of it being 5-D), because we are space-time entities of N(-2) properties (N(3) · N(-2) = N(0)); (3) solutions of fundamental questions, including the question about consciousness, may exist (N(5) and N(-2) have similar 5-D space structure, and consciousness may explain the Universe and Itself), and (4) N = 0 is the Nothing, which, through 5-D space and $[(-4)_7]$, as monad of mass, becomes Everything.

Table 2 Values of Hansdorff dimensions of a randomly Cantor middle third set for different dimension N, calculated from Eqs. (7) or (8) (ϕ - means Golden Mean)

N	$\mathbf{D_H^{C(N)}}$	$\left[1/\mathbf{D_H^{C(0)}}\right]^{\mathbf{N-1}}$
0	ϕ^0	ϕ
1	ϕ^1	1
2	ϕ^2	ϕ^{-1}
3	ϕ^3	ϕ^{-2}
4	ϕ^4	ϕ^{-3}
5	ϕ^5	ϕ^{-4}
⋮	⋮	⋮
∞	ϕ^∞	0

3. NEUROMOLECULAR COMPUTING

From Table 1 we see that dimension N = 1 looks like a "ghost" in this system. This one-dimensional entity ("string"), with unit sphere equal 2, is a dimension independent from all others, because there is no complement in the system through N = 0. According to this model its complement may be only N = 0, and/or through N = 0, all other dimensions.

3.1 DNA as one-dimensional information entity

DNA is composed of the so called nucleotides. One nucleotide is composed of three elements: a base, ribose and a phosphate group. Four types of bases may be represented: adenine, thymine, guanine and cytosine. Nucleotides are interconnected by hydrogen bonds in a specific double-helix structure [18]. From the aspect of organization of structure one such double-helix has the so-called aperiodic crystal [19]. DNA is one solution of 1-dimensional (N = 1) crystallization. The term "aperiodic" signifies the irregular interchange of bases inside the helix while the phosphates and ribose are located on the outside making up a periodic structure. The "irregular" repetition of the bases within the helix represent properties of living beings, which has a meaning, from the information point of view, only as a code system. The genetic code from the aspect of chemistry is based on a triplet and that in variation of four bases gives of total of $4^3 = 64$ possible codons for coding 20 amino acids.

3.2 Proteins as other side of the DNA code

The biochemical mechanism of protein synthesis is well-known. Messenger RNA (mRNA) is synthesized from one end of the DNA double helix, while the other end of the helix remains in the nucleus making possible the synthesis of another chain of DNA. The complete genetic information is preserved and remains inside the nucleus. From mRNA through carrier RNA (tRNA) to ribosomal RNA(rRNA) there is a continual transmission of the genetic information message, making in effect proteins, the other side of the genetic code. Amino acids of proteins are organized in a chain as a 1-dimensional (1-D) "knot" entity giving 3-D structure. There are thousands of different proteins in a cell. We will here consider only two: tubulin and clathrin.

3.2.1 DNA 1-D replacement: From tubulin through microtubules to centrioles

Tubulin is a type of globular (spherical) protein with about 450 amino acids. There exist α, β and γ subunits, but only α and β make a α–β heterodimer. Two subunits are able to bond as α–β heterodimers with the aid of the strong GTP [20].

Tubulin subunits make one new type of organizational structure, microtubules. Observing micotubules in a slice cut width wise they usually (about 85%) consist of 13 subunits: however, under the microscope it is possible to see numbers of subunits varying from 7 to 17. Subunits possess electric dipole moments, and the Curie symmetry ($\infty \infty$ /m) for ideal spheres [21]. Since experimental results link tubulin and microtubules to bioinformation processes such as memory and learning [22,23], microtubules have become the subject of intensive research as bioinformation

devices [24-26]. We have found that the microtubules possess two code systems, $K_1(13,2^6,5)$ and $K_2(24,3^4,13)$, which may provide communication inside and outside of microtubules [2,25]. This self-assembled 3-D cylindrical structures, similar to DNA, are solutions of 1-D crystallization. Tubulin subunits are arranged in a cylinder with golden mean properties [3]. The lattice of tubulin subunits is a pattern with divergence $(GM^+)^{-2}$, where $GM^+ = \left(\sqrt{5}+1\right)/2$. This structure forms a network in the cell which is responsible for intracellular transport, addressing, cell shape, growth form and many other dynamic activities [27,28].

Cell structure is organized from a central focal region near the nucleus called the microtubule organizing center (MTOC). The principle component of this center is the centriole, an organelle which consists of two perpendicular cylinders. Each of these cylinders, about 400 nm in length, is made up of nine microtubule triplets. The triplets are formed of one complete microtubule, with 13 protofilaments, and second and third partial microtubules with 10 protofilaments. Centrioles and MTOC play key roles in dynamic coordination of cell cytoplasm and its activities.

The centriole remains a central enigma in the cell biology and molecular biology. This enigmatic characterization may be resolved by considering centrioles as double Golden Mean devices: first through microtubules (divergence $(GM^+)^{-2}$) and second through microtubule nine-fold symmetry triplets. These triplets may have both left and right orientation with the golden mean angle [3].

3.2.2 Clathrin: DNA inverting itself into 0-D shell

Clathrin is the major component of coated vesicles, important organelles for intracellular material transfer including synaptic neurotransmitter release. Based on molecular weights, isoelectric points and antigenetic determinants, α and β tubulin subunits have been found to be associated with coated vesicles in both bovine brain and chicken liver [29]. However, there is evidence that synaptic vesicles are closely associated with microtubules, about five vesicles being radially disposed around a microtubule [27].

Clathrin is a Fullerene-like protein with a truncated icosahedron symmetry, as an object with 12 pentagons and 20 hexagons. Also, this protein may exist with 12 pentagons and as any number of hexagons. However, its process of self-assembly is by 0-D symmetry, as a process of crystallization around the point. This gives to clathrin a form of a shell (cage network); DNA so inverts part of its code into a protein with 3-D shell structure. The inside space of coated vesicles (shell) may be occupied or empty; experimentally, both situations have been observed [30].

It was shown that computing via self-assembly is possible, and the general self-assembly model of macromolecules based on quantum molecular computing has been proposed [31]. According to this model the free energy minimization of molecular computing may be used as a link between physics and biology, from an information point of view.

3.2.3 Magic water clusters: $[H_2O]_{20}$ *and* $[H_3O]^+@[H_2O]_{20}$

Although water has an overall neutral charge, the charges are asymmetrically distributed in space, which makes the molecule polar. The oxygen nucleus draws electrons away from the hydrogen nuclei, leaving these nuclei with a small net positive charge. On the other hand, the excess of electron density on the oxygen atom creates weakly negative regions. Because they are polarized, two or more adjacent water molecules can form a linkage known as a hydrogen bond. Molecules of water join together in a short-lived hydrogen-bonded lattice, cluster. Water itself has a slight tendency to ionize and therefore can act both as a weak acid and as a weak base. When it acts as an acid, it releases a proton to form a hydroxyl ion ($[OH]^-$). When it acts as a base, it accepts a proton to form a hydronium ion ($[H_3O]^+$).

The majority of water molecules identified from the X-ray electron density maps are individually bound to protein surfaces. Less frequently, but still in significant numbers, five-membered water rings and two-water five-fold symmetry clusters (hydrogen-bonds cage network) are found hydrogen-bonded to the protein surface [32,33].

The $[H_3O]^+@[H_2O]_{20}$ or [+@*20] cluster has been detected under numerous experimental conditions [34-36]. This cluster is very stable due to the strong Coulombic interaction between the incaged $[H_3O]^+$ ion and the surrounding 20 water molecules. This cluster has six local minima as its conformational state.

A basic cluster has a global minima $[H_2O]_{20}$ or [*20] with pentagonal dodecahedron symmetry (one of the five Platonic solids). This yield an association energy of formation of the [*20] from 20 separated water molecules of about 117 kcal/mol. This cluster (dodecahedron) is an empty cage with same elements of the symmetry and irreducible representations as icosahedron. (I_h symmetry group).

4. MODELS FOR BIOLOGICAL BASIS OF CONSCIOUSNESS

Consciousness can be viewed through: (1) DNA, as N = 1 entity, information realization to become N = 0 (makes own information complement in protein-water

interaction), and (2) hierarchy of unity of three wave functions information processes by Golden Mean law; the first level is cytoskeleton activities (sub-consciousness), the second level is neural network dynamics (consciousness), and the third is self-control of the brain (self-consciousness).

4.1 Model of sub-consciousness

Microtubules are the cell cylindrical organelles with an outer diameter of about 30 nm and an inner diameter approximately 14 nm. Microtubule paracrystalline energy states are defined by microtubule Golden Mean ($[GM^{+}]^{-2}$ = N[-2]) lattice structure and dynamics. Basic energy fields around and inside microtubules will be defined by the same, $[GM^{+}]^{-2}$ law. According to Eqs. (6) and (8) the complementary structures of Golden Mean will interact with microtubules giving a state of N[0] with $D_{H}^{C(0)}$. This phenomenon we shall define as the excitation of molecular information (a sparkle of information quanta) or *spark* of consciousness (sub-consciousness). One of the complementary structures to microtubules is the water cluster [*20]. The relationship between symmetry operations and energy states (like Hückel Molecular Orbital - HMO) of a water cluster [*20] for T_{1g}, T_{2g}, T_{1u}, and T_{2u} (energy-irreducible representations) are GM^{+} and GM^{-}. Since information quanta were defined as GM^{+}-GM^{-}=0!, the water cluster [*20] information dynamics in biological environment is an excellent candidate for the point of departure from consciousness. Because the interior of microtubules exists as an energy field of the Golden Mean law, water molecules will be naturally (spontaneously) assembled into water clusters [*20] inside of the tubes surface ($20H_2O \rightarrow [H_2O]_{20}$), according to screw symmetry of 13 protofilaments (Fig. 2a). Inside of the water clusters [*20] there is an empty space, and a quantum vacuum symmetry breaking approach to information processing of the wave function may be used. Inside of the microtubule and water cluster [*20], tube currents of very low intensity (10-100 nA) may appear. Weak photo emission is generated and electromagnetic field coupling with gravitational symmetry breaking in microtubular dissipative structures may be established. There is experimental evidence of such an influence of gravity on basic cellular activities, but mechanisms involved in gravitational effects on cells are still unknown [37]. Also, there is experimental evidence that microtubules are gravity sensitive [38], while centrioles may be the gravity spatio-temporal controller of the cell.

On the quantum mechanical level of microtubule-water clusters interaction, the interior of the tube (including centrioles) may provide electromagnetic-gravity waves coupling. On that level dynamics of equilibrium gravity-electromagnetic state under environmental weak fields influence may change states of sub-consciousness and determine its activities.

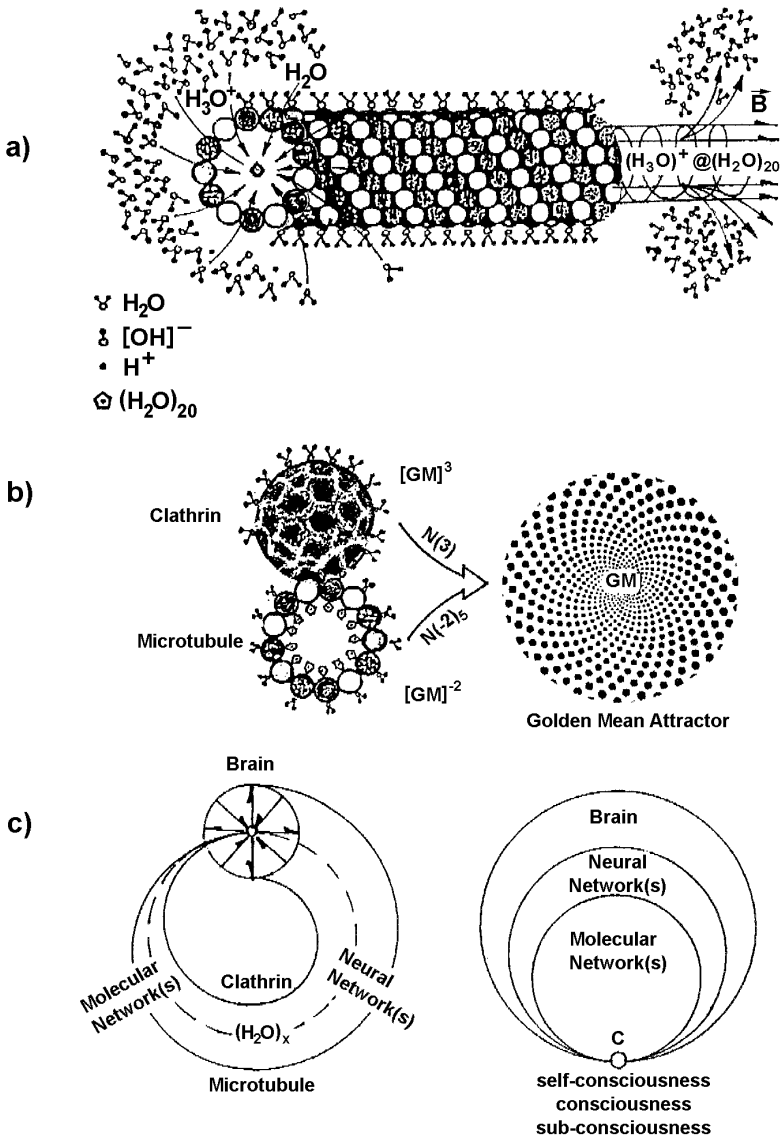

Figure 2 Concept of consciousness: a) Around microtubules are water molecules (H_2O, OH^-, H^+, 0^{-2}). Most water molecules are in form H_2O on outer surface of microtubule. Because inside the microtubule exists energy field by Golden Mean properties, water molecules will spontaneously assemble in water clusters $(H_2O)_{20}$ because they are complement (dual) from structure--energy-information point of view to microtubules; b) Cross section of microtubule-water-clathrin interaction. This is a place of coherence and synchronicity of dynamic activities molecular networks, neural network(s) and brain, through wave functions by Golden Mean structure-energy-information synergy; c) Three as the one: relationship between sub-consciousness, consciousness, and self-consciousness.

4.2 Model of consciousness

Cytoskeletal lattices include protein polymers of microtubules, actin, intermediate filaments and more than 15 other proteins. The major neuronal architectural element is the microtubule, which interacts with clathrin on the synapses. Clathrin, as a dual form of the water cluster [*20], interacts with microtubules from the outside of the tube by Golden Mean laws. This new phenomenon is a preamble to consciousness (Fig.2b). Microtubules, and particularly centrioles, are controllers of molecular network dynamic activities in the neuron. The cytoskeleton molecular network as a sub-neural factor of neuron networks [39,40] may play a very important role in sub-consciousness to consciousness processing integration. The parallel actions of many microtubule-clathrin interactions on synapses and dendrites by Golden Mean oscillations (molecular wave functions) are organized in many interconnecting networks, giving a new quality of information processing - consciousness.

4.3. Model of self-consciousness

Coherent control of quantum dynamics of microtubule-water clusters [+@*20] inside the tube may be the basis of self-consciousness. The outer layer of the microtubule is exposed to the effect of ions from the cytoplasm, affecting the changes of mass and dipole moment of subunits. Due to the change of the dipole moment and the mass of the subunits, microtubules oscillate with the following electromagnetic and acoustic frequencies: $f_{EM}=6\times10^{15}$ Hz and $f_{AC}= 5\times10^{10}$ Hz [41]. Ion currents of very low intensity may appear inside the tube by [+@*20] water cluster, which is moving away from one side of the microtubule. This moving is by screw symmetry law, according to energy minimization and configuration of protofilaments. Very low concentrations of [+@*20] ionic water cluster inside of the tube gives a relative dielectric permitittivity of $\varepsilon_r = 1+10^{-10}$. According to a relativistic relation between the frequencies measured in the two reference frames of microtubules, inside and outside, moving away from one to another it is possible to write $f_{in}(MT) = f_{out}(MT)\times K[\varepsilon_r]$ [42]. This gives the frequency range 0.2 to 120 Hz for the different number (from 13 to 91) of ionic water clusters [+@*20] inside the microtubule. This indicates that brainwaves (EEG) may originate from the oscillatory processes of microtubules and ionic water clusters [+@*20] through the collective quantum action of many (10^{12}) of the neurons in the brain. Based on such dynamics of ion density inside microtubules different states of consciousness might be generated through different excited frequencies. EEG may be explained by deterministic chaos generally [43,44] and as deterministic randomness of Cantor-set-like structure particularly [45], whose Hausdorff dimension is Golden Mean value.

Information processes on these three levels (molecular, cellular and brain) are in quantum coherence (Fig.2c), giving us spark-excited information state (consciousness) of our inner world ($[(-2)_5 = (GM^{+})^{-2}]$ space-time structures) by Golden Mean laws. Our inner 5-dimensional (micro) world is complement with 3-dimensional outer (macro) world, we are currently conscious of.

5. TESTING PROPOSED MODELS OF CONSCIOUSNESS

5.1 Biomedical testing

General anesthesia is one of the best ways to test models of human consciousness both *in vivo* and *in vitro*. There is evidence, *in vitro*, that anesthetics act in hydrophobic pockets of bacteria and firefly luciferase proteins [46,47]. These enzymes are important *in vitro* anesthetic systems because their easily measured photoemission is inhibited by anesthetics proportional to the anesthetics' clinical potencies. In similar way it is possible *in vitro* to measure wave functions of microtubule-water clusters by STM under the influence of anesthetics. It is interesting that one of the first molecular theories of general anesthesia was proposed as the hydrate-microcristal (pentagonal dodecahedra) of the clathrate type [48] similar to water clusters.

It was shown that halothane depolymerizes microtubules, but it occurred at higher than clinical concentrations of halothane [49]. According to our model of consciousness anesthetics act on water clusters (cage hydrogen network dynamics) and on the secondary structured dynamics of clathrin and tubulin, through hydrogen bonding. There is experimental evidence for anesthetic effects on the protein secondary structure [50,51], while anesthetic effects on water clusters will be investigated.

5.2 "Artificial brain" model testing

Fullerene C-60 has the same shape and symmetry properties as clathrin in brain [3]. Its structure crystallizes about the zero-dimension (N = 0), with a pure vacuum inside cage. Based on this molecule, with Golden Mean structure and energy properties, it will be possible to make artificial microtubule and molecular networks similar to the cytoskeleton. Also, based on Fullerene physics and chemistry it will be possible to build self-assembly systems: from artificial cells (neurons), as a simple one, through complex artificial neuron networks, to the "artificial brain" - by adopting the information physics principles from living matter.

We can then study dynamic responses of a complementary set of globally coupled quantum oscillators (biological brain-*electrical* and artificial brain-*magnetic*) with EEG randomly distributed frequencies, which will be, in the absence of external driving, able to exhibit a transition between the incoherent state and the coherent one with spontaneous synchronization (mapping of conscious contents from biological brain to "artificial brain" and vice versa). This may also solve one of the ultimate engineering goals: man-machine system interaction.

6. CONCLUSION

With our goal being to propose a realistic model of consciousness, we find that it is necessary to establish a new physical theory, which we named *information physics*. It was shown that biological information processing from DNA to proteins is information invertion itself. DNA is a 1-D (one-dimensional) information matrix, mapping itself into proteins as a 3-D information entities, which crystallizes around an axis - microtubule (1-D) and point - clathrin (0-D). Biological consciousness is the solution of the 1-D information entity (DNA) which invert itself into proteins (tubulins and clathrin), which interact with water clusters giving 0-D information entity - consciousness. According to this model the Hausdorff dimension of Cantor middle third set of zero-dimension is Golden Mean, as one of the major properties of consciousness. Although we see our outer world as 3-D, according to this model it is 5-D, because mass is a manifestation of dimension N = 0 in 5-D space structure. Biological information matrix, based on microtubules, is also 5-D, and there is hope that someday, someone, will be able to understand indeed the Universe and Consciousness itself.

We have considered biological consciousness through three levels: molecular (sub-consciousness), neural networks (consciousness) and brain (self-consciousness). The proposed models for testing are, first, based on molecular and cellular mechanism of general anesthesia, and second, based on mapping conscious contents from biological to "artificial brain".

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THE UNIVERSAL CONSCIOUSNESS AND THE UNIVERSAL CODE

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Abstract. There are many approaches to investigate consciousness. We propose one which utilize *logic* in the sense of *logos* (from the ancient Greek *logos* meaning *coding*, as a something that was at the beginning). For living beings their *matter logos* point of departure is the periodic system of elements because genetic code is its second hand side. In the scientific work of D.I.Mendeleev the important aspects of periodic law were examined, which the 20th century scientists have never adequately understood. Also, Darwin's diagram, in his book *Origin of Species*, represents a specific code, which is the first example of the code model and the code system in biological science. What is the point of departure of *mind logos* it is difficult to say, but on the consciousness level, after five thousand years in the development of the binary numbering system, the time has become ripe for a unification of the two different approaches in studying the universe and human beings: the global-integral method of the Ancient East, based primarily on speculation (logic of *speculative mind*), and the single-partial method of the Modern West, based primarily on experimentation (the logic of *natural mind*). Even more, today it is becoming evident that a scientific basis of human consciousness cannot be understood without such unification. Before such a unification can be done, one possible general hypothesis about the existence of a universal *Mind/ Matter* code should be tested and proven. This paper is subject of that kind of consideration.

***Keywords**: logic, periodic system of elements, genetic code, microtubules, water, Yin-Yang code, consciousness*

1. INTRODUCTION

There are many approaches in investigating consciousness. We propose one which utilizes logic in the sense of *logos* (from the ancient Greek *logos* meaning something that was at the beginning). In spite of this seemingly very narrow approach, from the physiological-psychological aspect it is more extensive. More in accordance with Russel's [1], and Vygotskii's [2] and less with Ashby's [3] and Arbib's [4] views (Russel, p. 168: "... we are said to be 'conscious of' something; in this sense, 'consciousness' is a relation"; p. 170: "The ... relation to an 'object', it could be said, is characteristic of every kind of consciousness", p. 173: "Nevertheless we can distinguish 'mental' events from others ..."; Vygotskii, first chapter: "... consciousness is a unity of all functions"; Arbib, p. 1: "... all the functioning of the nervous system relevant to our study is mediated solely by passage of electrical impulses by cells we call neurons"; Ashby, p. 11: "... the book

deals with only one of the properties of the brain, and with property - learning - that has long been recognized to have no necessary dependence on consciousness"; p. 12: " And until such a method ... the facts of consciousness cannot be used in scientific method"). Our fundamental hypothesis in establishing our approach is that the investigation of the consciousness must always consider a whole system as a unity of physiological (including biochemical and biophysical) - psychological-logical characteristics; with two subsystems: physiological-psychological and psychological-logical. Considering this concept, together with Russel's idea about consciousness as a relation to objects in sense to be 'consciousness of' something, with Sartre's idea [5] that any consciousness is the consciousness about something, with Petronijević's idea [6] that the contents of the consciousness are the notions, and finally, with Einstein's idea [7] that all notions within 'natural laws' are from the space-time nature, we will show how human consciousness in some specific ways has expressed itself in the various works by different creative investigators through different epochs. On the other hand we will show that this human consciousness is in a specific relation with a universal consciousness within universal code.

2. PRELIMINARIES

More than any other scientists, Crick and Einstein are responsible for our link between the molecular basis of life and consciousness. Crick made first and important step, with arguments that consciousness is a property of molecular activities in neurons and networks of neurons in our brain [8], while a serious analysis of complete works of Einstein lead to the conclusion that when he speaks about the four-dimensional continuum of space-time, he means in fact three-four-dimensionality. This opens a possibility to speak about coding coordinates and coding spaces; by doing this, each Boole's space characterized by three-quaternity must be taken as Boole-Einstein's space. In fact Coding Space (CS) unavoidably should to be Coding Space-Time (CST), what is subject of the information physics as a new scientific discipline of space-time structures [9,10].

The basic parameters which determine physico-chemical characteristics of *a system* of stable chemical elements are: atomic number, number of period, number of the group and number of isotopes. Mendeleev never used word *Table*, what we usually do, to present his work, but *System*. His original *System* of elements is different from our today's *Table* of elements. Science of 20th century escapes Mendeleev "mysterious" form of his system of elements, saying that Mendeleev made some arithmetical errors (ref. [11], p. 185). Mendeleev's "errors", or our inadequate understanding of his work, is the information (coding system $3^4 = 81$ and $4^3 = 64$) approach to elements. Information approach as coding approach. The coding system $3^4 = 81$ - because within first 84 chemical elements (from H = 1 to the Po = 84) there are exactly 81 stable elements. The coding system $4^3 = 64$ - because 84

minus 20 "monoisotope" elements equals 64 (cf. ref. [12], ch. 27, sect. "Relations odd-even", where Gould says that all even elements to the polonium, Po = 84, have minimally two stable isotopes, except beryllium; cf. ref. [13], where Rakočević says that within chemical code there are exactly 84 elements; cf. 64 hexagrams in Fig. 5 and 81 tetragrams in Fig. 6). Mendeleev clearly and precisely gave the system of chemical elements as a four-dimensional Boolean hypercube [14]. The same approach, based on Boolean hypercube, has been used recently by Kauffman to explain the origins of order as point of departure of self-organization and selection in evolution [15].

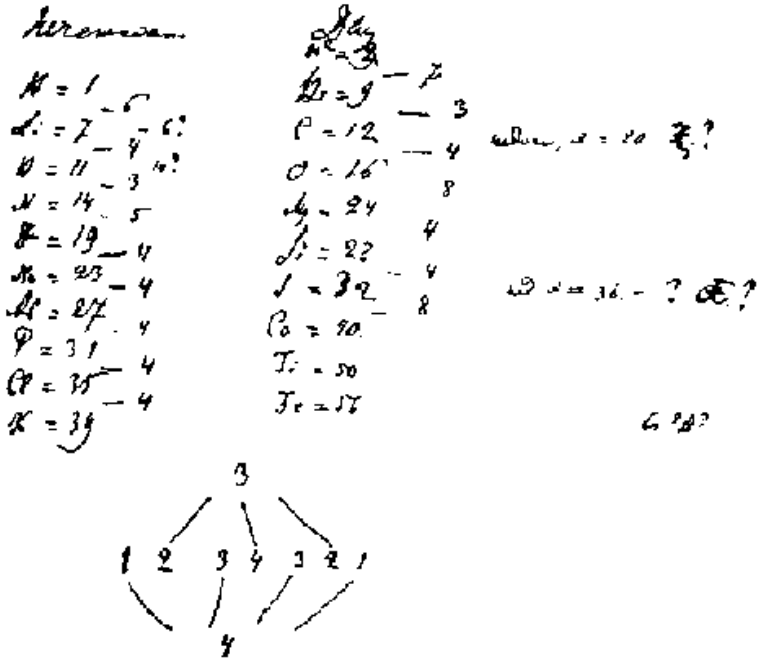


Figure 1 The universal consciousness on the universal code of the nature: the Mendeleev's system of chemical elements oddity-evenness principle; the valence trinity-quaternity system; the atomic mass distances integer system.

In the scientific work of D.I. Mendeleev, especially his original manuscript works (see ref. [11], pp. 128-129), three important aspects of periodic law were examined, which have never been adequately understood by 20th century science. These are: (1) the system relations among elements including odd-even principle, (2) spaciousness i.e. three-dimensionality (Figs. 1-2), and (3) cyclicity (photocopy XII in Kedrov: Cu, Ag, Au within first and after that within eighth group at the end, parenthetically). From these facts it follows that the third dimension of the periodic system as a "New dimension for Mendeleev" [16] is not necessary because Mendeleev was conscious of dimension 100 years ago. Also, Mendeleev was

conscious of the problem of "rare earth", although there are different opinions (ref. [16], p. 13: "The two versions differ simply in their arrangements to accommodate elements such as the rare earths, but the result must be to leave many with the impression that Mendeleev had not made up his mind about something of importance"). In his long periods Table (ref. [11], p. 188) Mendeleev gave a specific position to the first element of "rare earth", i.e. lantanides (Ce) - not in the third but in fourth group; then still 13 groups for 13 lantanides. If so, Mendeleev must have been seen conscious that the short periods Table with 8 groups of elements corresponds with cube, and long periods Table with a hypercube (8 group of non-rare earth elements plus 14 group of yes-rare earth elements with a superposition equal 14 groups; then: 14 groups plus the first group at the end, and plus the zeroth group equal 16 groups). On the other hand, Mendeleev was conscious of the fact that there must be 4 types of elements with correspondence to the square (for details see ref. [14], pp. 197-200). Bearing in mind all these Mendeleev's insights, it was possible to determine the definitive real positions of elements within 3-4 dimensional periodic system (ref. [13], pp. 19-22). Other creative investigators, primarily Darwin and Mendel [14] were conscious of square-cube-hypercube relations within natural systems.

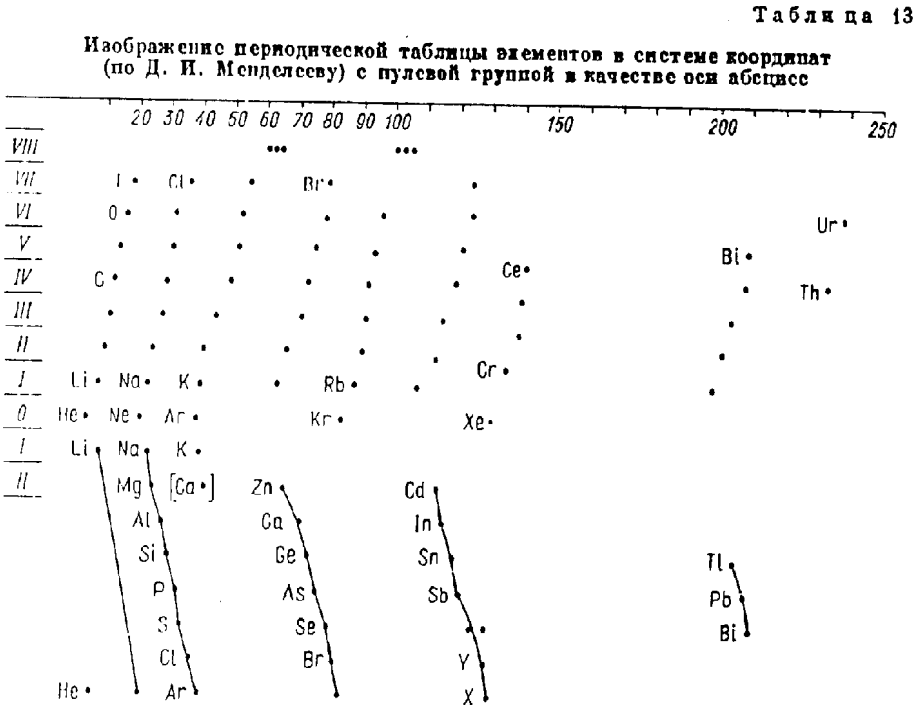


Figure 2 The universal consciousness on the universal code of the nature: the Mendeleev's three-dimensional periodic system as unity of cube-sphere; cube: through the three coordinates; sphere: the noble elements are at all three coordinates.

Darwin's diagram, binary tree, represents the first systematic information approach to the analysis of the relations between organisms [17]. This is the only diagram in his book *Origin of Species* and it represents a model of interpretations of the origin of varieties, species, genera and higher systematic categories. By its essence, his diagram represents a specific code-model and code-system as the first example in biological science. Relations of the noted elements within this code system correspond to the relations of the organisms in the natural systems. Hidden message of this diagram now is clear: if the natural systems are at the same time the coding systems, the only adequate and complete way of description and interpretation of such systems would be the creation of adequate code models with adequately corresponding relations between the elements of the one and the other model.

The main idea which is in the basis of the diagram - binary tree, is the realization of the logic of systematization and classification, separation of the parts within the whole, as well as the regularity of the hierarchy of the levels. The accordance of this logic with the model of classification of the number systems with the number basis $N_2 = 2(2n+1)$, where $n = 0,1,2,3$, is directly obvious. So, we have for $n = 0$, $N = 2$, which corresponds to the division of the binary tree to the left tree and the right tree. This is exactly what Darwin discussed on the relations during the evolution only along two lines at the beginning of which "species (A)" and "species (I)" occur: " These two species (A) and (I), were also supposed to be very common and widely diffused species, so that they must originally have had some advantages over most of the other species of the genus". The obvious characteristic of the Darwin's diagram of the binary tree is that each transition to the next level completely follows the logic of the Gray code, since only a unit change is allowed [14].

3. LOGIC OF MOLECULES OF LIFE

The problem of accordance-discordance of the genetic code (4^3=64) and its physico-chemical basis was firstly stated by Crick who demonstrated that this problem is impossible to separate from the questions related to the ratio of probabilistic and deterministic in the coding process: the fact that codons X_1, X_2, X_3 ... are coding for amino acid Y results from numerous accidental processes during the evolution, or here strict (deterministic) reasons could be also included [18,19].

The very approach to the three-four-dimensional system of both the chemical code (Mendeleev) and the genetic code should be integral one: it has to be emerging logic approach. We have shown [14] that atomic mass and number of isotopes represent the principal determinants of the chemical code ($3^4 = 81$), while binary values of codons and amino acids represent the principal determinants of the genetic code ($2^6 = 64$). (Figs. 3-4).

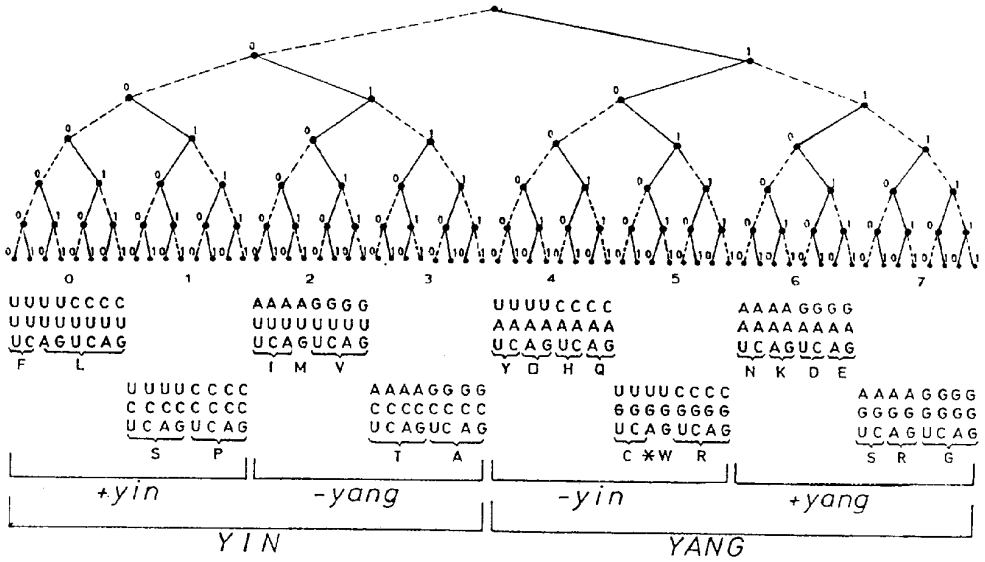


Figure 3 The universal consciousness on the universal code of the nature: the genetic code binary tree is in full accordance with the yin-yang binary tree in the oldest book - I Ching. The relations between 64 codons and 64 hexagrams: to each zero corresponds a broken line; to each one corresponds an unbroken line (see ref. [14], p. 274). This binary tree of the genetic code with the order of the eight families of codons (rosettes), which corresponds to the series of natural numbers (0-7). The four 16-codon families begin with broken lines for +Yin and/or +Yang states; full lines for -Yin and/or -Yang states, reflecting the greater or lesser influence of bases of the *Py* and/or *Pu* type.

3.1 The Number of Trinity-Quaternity

The basic concept from which we start is the Boolean logical square. This hidden square exists within the Gray code model of genetic code [20,21]. The Gray code model of the genetic code can be *per se* developed in two types of the binary tree: (1) the binary tree which keeps the logic of the Gray code having characteristic that "two adjacent symbols differ at only one bit" [20], and (2) the binary tree with the logic of natural numbers series "for the numbers 0-63" [21]. With the first type of binary tree, the distances between codons are the unit Hamming distances if "measured" by weight, i.e. by norm of Boolean vector, while with the second type of binary tree the distances are also the unit ones if "measured" via the vector number.

According to the logic of the Boole's square, longitudinal diagonal of the Boole's cube has to be labeled by the following sequence of corners: 1076. The end-corner, 1776, in the diagonal is optimal only in the system of trinity-quaternity (*TQ*): 1076 + 700 = 1776 (trinity because it is cube; quaternity because there are four positions; optimal because the corner 7 of the three-digit-record does not change position during "transition" to four-digit-record). *TQ* system should be understood as the unity of

Boole-Einstein's cube-hypercube: there are two sevens at the longitudinal diagonal as a result of permanent coping 0-7 and 7-0 (within the frame of the cube) and/or as a result of permanent motion from starting to middle point and backwards, i.e. from end-point to middle point and backwards (within the frame of the hypercube). Sevens from longitudinal diagonal are intercrossed by two sevens of the middle diagonal (within the frame of hypercube) which appear as a result of permanent coping 7-8 and 8-7. Therefore, at each moment of time, there is a system 0777-7777 in Boole-Einstein's coding space, and/or 1776-17776, if we take into account cyclicity of the system.

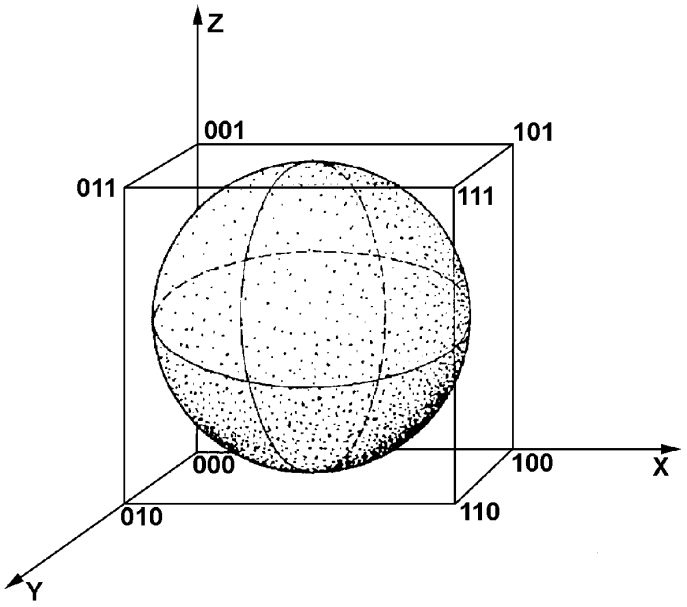


Figure 4 The universal consciousness on the universal code of nature: the *light* model of the genetic code is in full accordance with Mendeleev's cube-sphere model (Fig. 2) of the chemical code (for details see ref. [14], p. 54).

3.2 Genetic Code as TQ System

Analysis of the Crick's papers published immediately after 1966, upon definitive establishment of the Table of codons, demonstrates his sagacious observation of the problems imposed by Table itself, in spite of its beauty and symmetry. Determination of the number of problems and their denomination are ours, while the original statements are those of Crick.

(1) *Problem of the alphabets (problem of coding)*: Four-letter language of the nucleic acids has been studied in the meantime and we know how it controls 20-letter language (amino acids) of the proteins. However, in spite of the fact that numerous problems remained unsolved, this knowledge is certain;

(2) *Problem of the neighborhood (both codons and amino acids)*: Neighbor amino acids are coded for by neighbor codons;

(3) *Problem of similarity of codons*: It is sure that triplets coding for the same amino acid are most often very similar;

(4) *Problem of the position of base I, II, III in triplet*: In any case triplets with U and C at the end of the codon are coding for the same amino acid, and this is also very often the case with the triplets containing A and G as the end base;

(5) *Problem of selectivity of base I, II, III within a codon*: Amino acid is chosen mainly by the first two bases in a triplet;

(6) *Problem of a sign*: Is the allotment of a triplet to amino acids at random, or there are structural reason for this?

(7) *Problem of the meaning*: What is the sense of the synonymy through the third base, and what is the sense of the exceptions?

(8) *Problem of the form*: Form of the genetic code is established with a considerable certainty;

(9) *Problem of the essence (what is the "corner stone")*: Genetic code is an important corner stone at the long path of molecular biology and biological life;

(10) *Problem of the origin and evolution of the genetic code*: When we answer all these questions, the question of the origin of the genetic code will remain as the major problem. Is the genetic code the result of a series of evolutional coincidences? The origin of the genetic code will remain as the major problem.

Two amino acids; *serine* and *arginine* have been the main problem not only for Crick, but also for all other researchers undertaking serious studies on the essence of the genetic code. The codons coding for these two amino acids for each of them are very different and even separated in the table. This is then the reason Crick could not claim with certainty that similar codons code for similar amino acids (this should be expected on the basis of chemistry) or that neighbor codons code for the same amino acid. So, Crick could only say that they are "the most often very similar". Position of the third base within a triplet makes new problems. Coding process is not affected when pyrimidine bases (U and C) appear in the third position, i.e. the same amino acid is coded (synonymy). If we use information-topological model of the genetic code it is practically possible to solve all ten Crick's problems of genetic code: four-letter language is at the same time the language and the chemical essence; similar codons indeed code for similar amino acid and again without an exception; neighbor codons code for the same amino acid and again without an exception. In our information geometry approach [14] genetic code is completely characterized by entity of *TQ* system. Two pyrimidine (*Py*) and two purine (*Pu*) bases are inevitably expressed in the coding space as the system 3+1 (three with oxo-group and one without it, or three with amino group and one without it). Therefore the number of codons in the table of the genetic code by positions in four

groups should read from an aspect of the main coding position. In spite of this distinction 3+1 only on the basis of numbers presented in this manner it is impossible to understand possible physico-chemical meaning of *TQ* system in the genetic code without an analysis of the internal structure. Each position consisting of 16 units can be taken as position with the structure 8:8 what makes sense from a physico-chemical aspect, since 16 families of codons $(1 \cdot 16) \cdot 4 = 64$ could be understood also as a system of $(2 \cdot 8) \cdot 4 = 64$ codons. In one family of higher order (eight-membered one) there can be 8 codons with *Py* base in the first position, and/or 8 codons with *Pu* base in the first position. However, there is a question whether classifications such as (8-1):(8+1), (8-2):(8+2), or some others make sense? We will put forward the *hypothesis* that the classification (8-1): (8+1), so 7:9 makes sense also from an aspect of strictly determined physico-chemical parameters such as hydropathy (H) or polarity (P), as well as from an aspect of the principal parameter of the binary value. (For details see ref. [14], pp. 253 and 255-260). It was proposed the existence of binary values for the entities of two pyrimidine and two purine bases: *U(00), C(01), G(10), A(11)* [22]. Swanson made the same assumption, but with a significant difference: *U(00), C(01), A(10), G(11)* [20]. She showed that the binary record of a codon must begin with the second (middle) and not the first base, as was proposed by Schonberger. When we used our *TQ* coding system we satisfied all Crick's genetic code problems and find similarity with quantization the magnetic quantum number (-3,-2,-1,0,+1,+2,+3). This indicate the basic biomolecular information processing associate with quantum field trough coding. Our results of genetic code are summarized in ref. [14]. We can say that genetic code is preamble of biological consciousness which arise in proteins-water interaction and through activities of cell (molecular networks), body network, neural networks and brain, that lead human beings to be conscious [8,10].

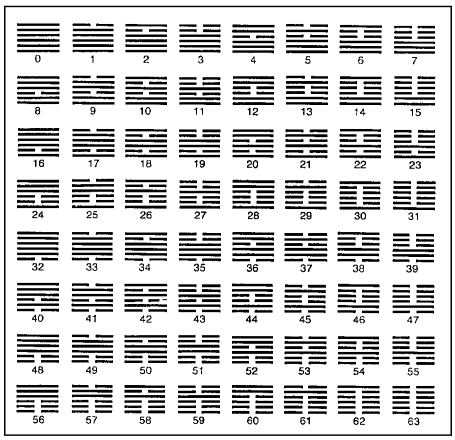


Figure 5 Speculative system of ancient China based on hexagonal arrangement: It consists of 64 hexagrams ($2^6 = 64$), which display every possible combination of archetypal human situations – along with thousands of variations caused by changing lines. Notice that an inverse countdown is possible. In such a case the 63rd number is zeroth. If so, then $2 \cdot 6$ and 2^6 are the numbers of lines and hexagrams respectively.

3.3 Microtubules Coding System

Microtubules coding system was identified by Koruga [23]. There is microtubule coding system of two codes; $K_1[13,2^6,5]$ and $K_2[24,3^4,13]$. First code, K_1, is result of tubulin subunits packing in protofilaments by screw symmetry. This code has 64 codewords, length 13 and distance 5 (the best known binary error-correcting code). Second code, K_2, is result of interaction of 24 tubulin subunits and high molecular weight MAP (microtubule-associated proteins). This code has 81 codewords, length 24 and distance 13 (the best efficient code for information transmission) (cf. these 64 and 81 codewords with analogous "codewords" within chemical code, mentioned in Preliminaries).

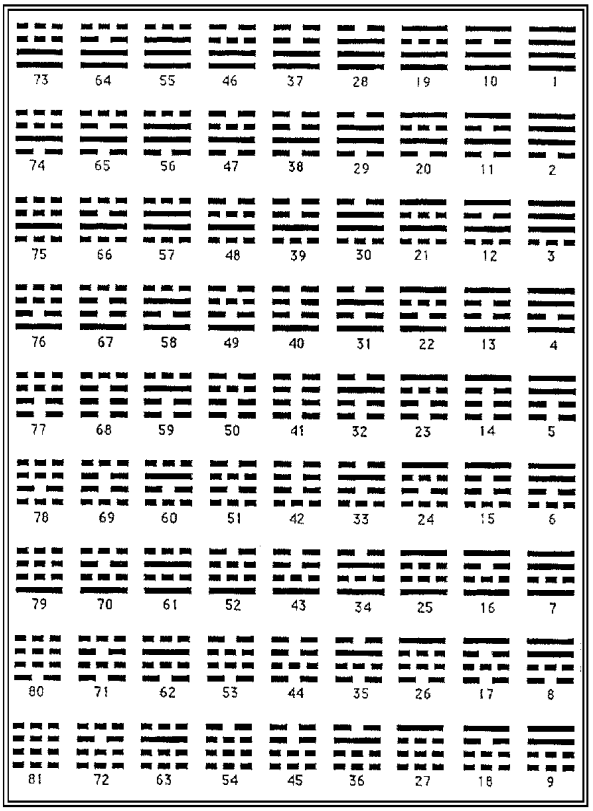


Figure 6 Speculative system of ancient China based on tetragram arrangement: A tetragram is constructed from four stacked lines of three types (solid, broken, and twice-broken). There are 81 possible combinations of these three types of lines (3^4=81). It is no accident that ancient Chinese book *Tao Te Ching* has eighty-one chapters, what is also a significant number to those Chinese philosophers who treasured the symmetry of numbers. Notice that an inverse countdown is possible. In such a case the 81st number is zeroth. If so, then $3 \cdot 4$ and 3^4 are the numbers of lines and tetragrams, respectively.

3.4 Biological Water Mystery

The essential role of water has been recognized in all studies of biological processes, but it is a paradox that we know very little about order and properties of "biological water". Water seems to be the fastest solvent, because simulations predict and experiments verified femtosecond dynamics of water [24]. It is well known that water molecules may be organized in different ways but one of the most promising is the clusters organization. Water clusters may exist with 10 to 1000 water molecules. An approach of water cluster cellular automata (WCCA) may be the right way to solve the problem of its mysterious role in biological information processes. If we look at cell from the system theory approach, biological water seems to be "*intelligent solvent*".

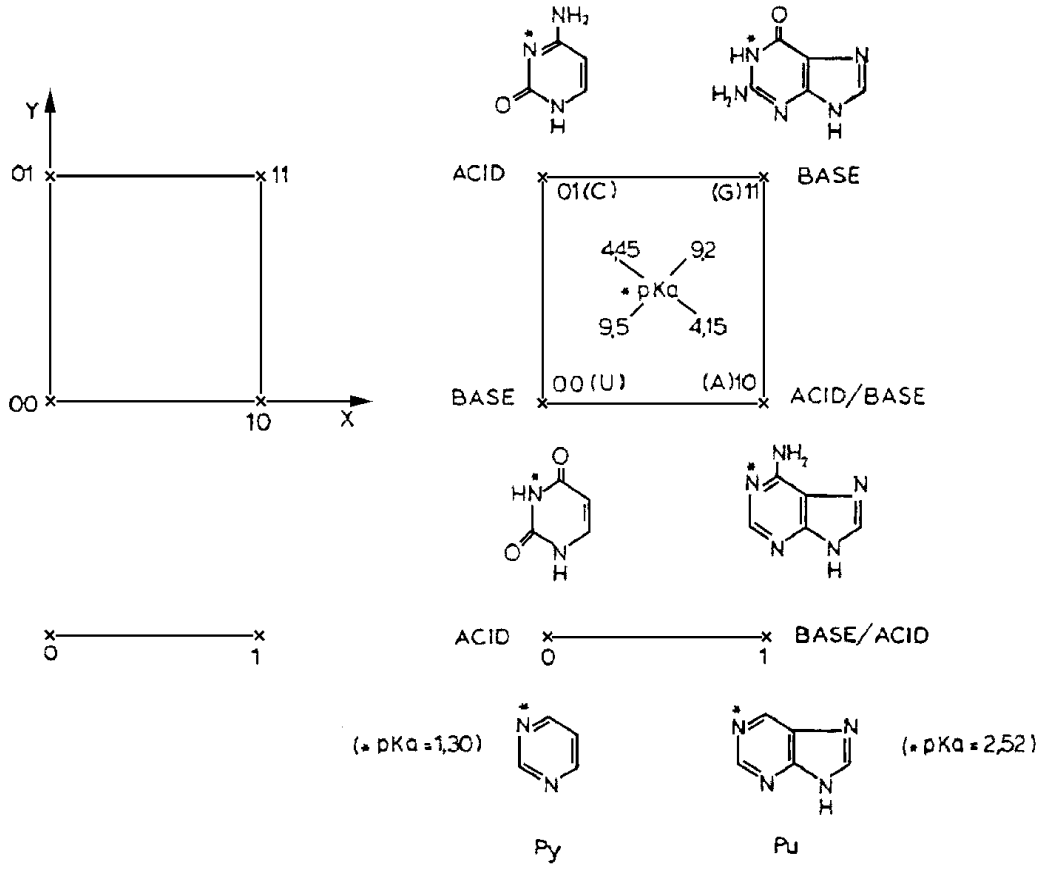


Figure 7 The universal consciousness on the universal code of Nature: the Boolean logical square of the genetic code is in full accordance with the Aristotelian (Boolean) logical square of four entities (cf. Fig. 8) (For details see ref. [14], p. 8).

4. LOGIC OF SPECULATIVE MIND

The logic of *natural mind* is primary result of human brain adaptation through its interaction with environment (Nature), while logic of human *speculative mind* is primary result of human field based mind interaction with *Mind Itself*. The best example of speculative mind related to natural mind is Chinese concept of *Yin-Yang*, while Chinese concept of *Dao* may be related to *Mind Itself*. Schonberger was the first to point the possibility of making the *I Ching* and the genetic code conform to the same model by using binary records [22].

4.1 Dao and Mind Itself

From a scientific point of view we do not know yet what *Mind Itself* is, but if we identified *Mind Itself* with *Dao* we can learn that

The Dao that can be expressed
Is not the Dao of Absolute.
The name that can be named
Is not the name of the Absolute.

The Dao is empty and yet useful;
Somehow it never fills up.
So profound!
It resembles the source of All Things.

4.2 Yin-Yang and Natural Mind

We shall demonstrate the underlying meaning of the link, coherence and interdependence of the natural code (*natural mind*) and the I Ching code (*speculative mind*). We shall show that there is a complete and perfect correspondence between the *Yin-Yang* entities in the I Ching code ($2^6 = 64$) and the pyrimidine-purine entities in the genetic code. Our starting point has been Stent's discovering that *Yang* (the male or light principle) is identified with the purine bases and *Yin* (the female or dark principle) with pyrimidine bases [25]. It was known in the ancient China that the Yin-Yang entities may be extended, so there can be +Yin (Great Yin) and -Yin (Lesser Yin) or +Yang (Great Yang) and -Yang (Lesser Yang), what lead us to new conclusions, which can be summed up in Figs. 3-8 and the following points:

(1) Boole's logical square lies at the heart of the I Ching as well as of all natural codes. The logical square of the four entities of the I Ching should be turned

180^0 to make it correspond to the logic square of the four elements known to Aristotle: *Air* and *Fire* associated with *Yang*, and *Earth* and *Water* with *Yin* (Fig. 8).

(2) There is complete congruence and correspondence between the six-bit binary records for the 64 codons and the binary records for the 64 hexagrams in the I Ching (Fig. 5).

(3) The binary tree of the *I Ching* should be turned 180^0 for it to fit exactly over the binary tree of the genetic code; then both binary trees correspond to Farey's binary tree, which determines the quasiperiodical transition to deterministic chaos (cf. ref. [14], p. 280).

(4) The eight trigrams in the *I Ching* are analogous to the eight rosettes, i.e. eight families of codons on the binary tree of the genetic code (Fig. 3).

However, the system: *+Yang, -Yang, +Yin, -Yin* may be presented as $3^4 = 81$ (Fig. 6). This indicates that *Yin-Yang* coding system is the same as microtubules coding system

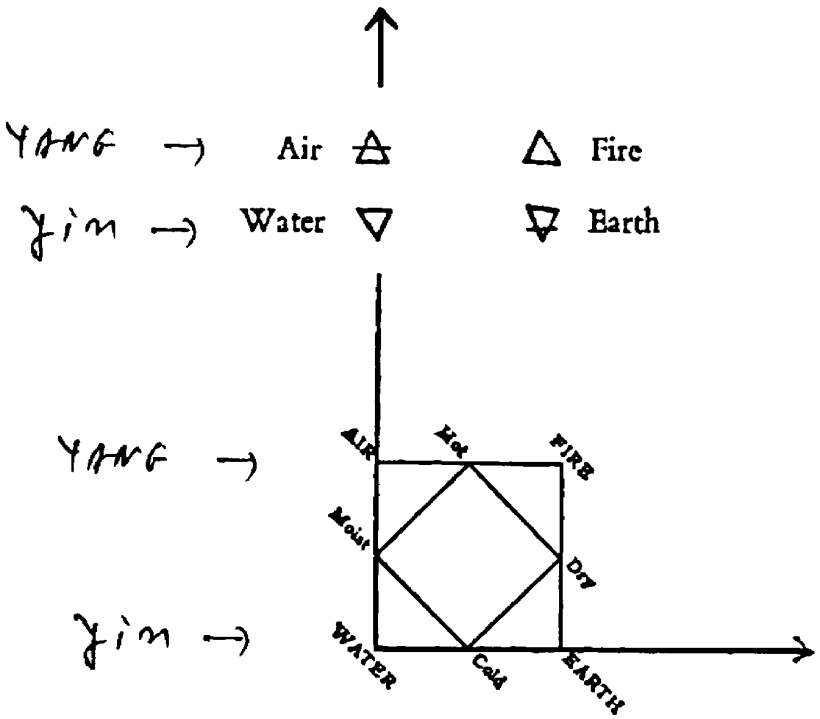
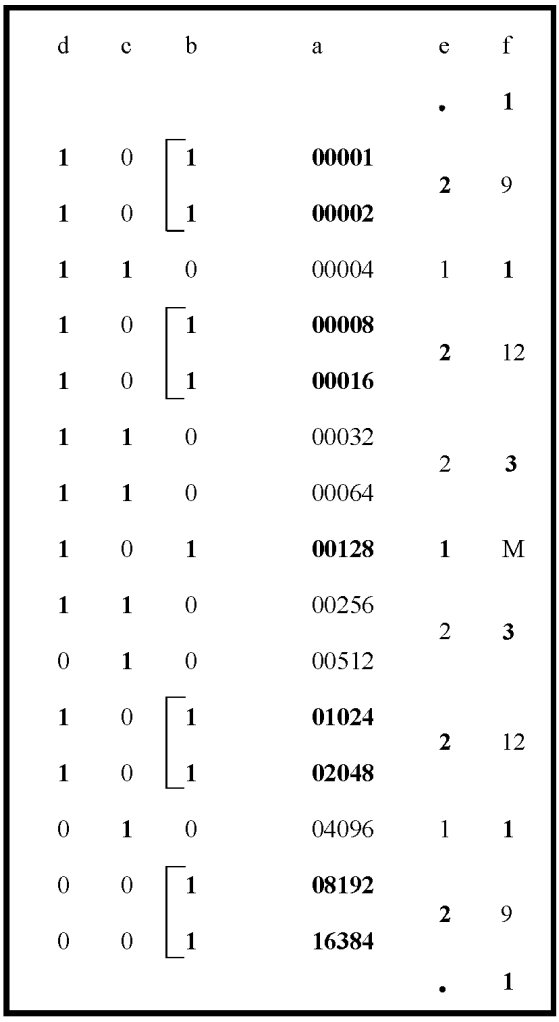


Figure 8 The universal consciousness on the universal code of Nature: the Alchemists' (Boolean) logical square follows from Aristotelian square; both are in accordance with the yin-yang system and with the genetic code logical square (cf. Fig. 7); further, they are in accordance with the fundamental particles square: neutrino (00), electron (01), quark down (10), quark up (11). For the (Boolean) logical square regarding the fundamental particles see ref. [14], p. 283.

5. FINAL COMMENTS

In fact the three quoted aspects of periodic law are of great importance today, when it has been demonstrated that the system entity, spatiality, periodicity and cyclicity are the most important characteristics of the genetic code (Figs. 3-4). From these figures it is clear why it is sensible to speak about the chemical code in connection with the genetic code. There are certain aspects of correspondence and coherence of the two codes: (1) within the genetic code there are exactly 61 amino acid (stable aggregation) meaning codon situations, plus 3 breaks in amino acid meaning (3 "stop" codons), plus 20 non-codon situations (20 protein amino acids); (2) within the chemical code there are exactly 61 situations (in the form of stable aggregations) which have multi-isotope meaning, plus 3 breaks in stable isotope (3 "stop" situations: Tc, Pm, Po), plus 20 non-(stable) isotope situations (20 "mono isotope" elements). Thus altogether there are 84 entities within both the genetic, and chemical codes. This, is the very topic: the chemical code, built on the very principles mentioned and in complete accordance with the genetic code. Such a surprisingly simple model at the same time represents the Logical-Informational and Geometrical-Homeomorphous-Topological (LIGHT) system of the Boolean cube-hypercube with an inscribed sphere-hypersphere (Fig. 4). The 8 vertices of the cube in Fig. 4 correspond with the 8 rosettes on the binary tree in Fig. 3 (8 families of codons); the 16 vertices of imagined hypercube correspond with 16 families of codons on the binary tree.

The basic (main) relations, determinants and invariants within the binary tree, i.e. within the system of cube-hypercube are the relations of a Boolean logical square. There are 4 types of molecules within the genetic code: Uracil (U = 00) with number 0 of Boolean vector, Cytosine (C = 01) with number 1, Adenine (A = 10) with number 2 and guanine (G = 11) with number 3 of Boolean vector (Fig. 7). Also, there are 4 types of chemical elements: s(00), p(01), d(10) and f(11) in relations of the Boolean logical square; plus 4 types of fundamental particles: neutrino (00), electron (01), quark down (10) and quark up (11). Fig. 8 illustrates the consciousness about logical square relations within the Universe of Aristotle and Alchemists. The periodicity and cyclicity within the genetic, as well as within the chemical code, are in accordance with periodicity and cyclicity of the natural number systems with the base $N_1 = 2^n$ (n = 1, ..., 6) and $N_2 = 2(2n+1) = 4n+2$ (n = 0, ..., 5). The relations within these mathematical number systems lead to the Golden Mean, as one of the most important Laws in Nature (for details, see ref. [14]). It could be said that these number systems are the natural number systems. And then a new surprise: human consciousness in some specific way expresses itself through masterpieces such as those written by Goethe, Shakespeare, Tolstoy, Njegoš. We find their compositions were written according to the same Law as possessed by the chemical and genetic codes - the Golden Mean. Fig. 9 shows how Homer and Njegoš generated their works from the binary sequence $N_1 = 2^n$.



d	c	b	a	e	f
				•	**1**
1	0	**1**	**00001**	**2**	9
1	0	**1**	**00002**		
1	**1**	0	00004	1	**1**
1	0	**1**	**00008**	**2**	12
1	0	**1**	**00016**		
1	**1**	0	00032	2	**3**
1	**1**	0	00064		
1	0	**1**	**00128**	**1**	M
1	**1**	0	00256	2	**3**
0	**1**	0	00512		
1	0	**1**	**01024**	**2**	12
1	0	**1**	**02048**		
0	**1**	0	04096	1	**1**
0	0	**1**	**08192**	**2**	9
0	0	**1**	**16384**		
				•	**1**

Figure 9 The universal consciousness on the universal code of Nature: the Homer's and Njegoš's (Boolean) space sequence, $N=2^n$. (a) The binary sequence whose sum is $2^{15}-1=32767$; (b) Homer's choice: $27803_{10} = 66233_8 = 110110010011011_2$ (the number of verses for *Iliad* plus *Odyssey*); (c) Njegoš's choice: $4964_{10} = 11544_8 = 001001101100100_2$ (*The Mountain Wreath*: printed version 2819 verses plus 318 person-scenes, plus 116 pages for printing = 3253; manuscript version 1528 verses plus 150 person-scenes plus 033 pages = 1711; all together - the total spaces of *The Wreath*: 3253 + 1711 = 4964); Homer's plus Njegoš's system: $66233_8 + 11544_8 = 77777_8$; (d) Homer's choice: $3583_{10} = 6777_8 = 000110111111111_2$. The number 3583 represents the difference of *Iliad* and *Odyssey*: 15693 - 12110 = 3583. The relation between two numbers 77777_8 and 6777_8 was given through a logic program: to exclude first position, and then - to write the result (7777_8); after that: to exclude first unit in the first position, and, then to write the result (6777_8). The choice logic for the number $3583_{10} = 6777_8$ is as follows. From the total sequence (2^{15} - 1) to exclude all the situations that contain the whole third perfect number 496; (e) The number of Homer's yes-choice and non-choice situations; (f) The (in literary science) known composition sequence of *Iliad*: from the middle point Mission to Achilles) 1 day full, 9 empty of events etc.

From this discussion it follows: it makes sense to give some separate hypotheses for further investigation. For example: (1) Human consciousness as a specific brain-computer code must be determined by Boolean spaces; (2) Human consciousness in the form of human language must be determined by Boolean logical square (Fig. 10); (3) Human consciousness as logical reason (syllogism etc.) must also be determined by Boolean logical square (Fig. 11).

PRINCIPES DE PHONOLOGIE

On obtient ainsi le schéma des variations possibles :

	I	II	III	IV
a	Expiration	Expiration	Expiration	Expiration
b	Art. bucc.	Art. bucc.	Art. bucc.	Art. bucc.
c	[]	~~~	[]	~~~
d	[]	[]	.....	.....

La colonne I désigne les sons *sourds*. II les sons *sonores*, III les sons sourds nasalisés, IV les sons sonores nasalisés.

Mais une inconnue subsiste : la nature de l'articulation buccale ; il importe donc d'en déterminer les variétés possibles.

Figure 10 The universal consciousness on the universal code of Nature: De Saussure's sound system of natural language can be seen as a specific Boolean logical square: I(00), III(01), II(10), IV(11) ... (cf. De Saussure's natural language designation system ref. [26], p. 70 and R. Swanson's genetic code designation system ref. [14], p. 10).

6. CONCLUSIONS

The periodicity and cyclicity within the periodic system of elements, genetic code, microtubule code and *Yin-Yang* system, are in accordance with periodicity and cyclicity of the natural number systems with the base $N_1 = 2^n$ (n = 1, ..., 6) and $N_2 = 2(2n+1)$ (n = 0, ..., 5). The relation within these mathematical number systems is the *Golden Mean.*

To understand the biophysical mechanism of information processes the main investigation should be done in both fields water coding system(s) and water-biomolecules interaction. There is a strong indication that water code(s) should be given by natural systems, N_1 and/or N_2.

Our main hypothesis in establishing our approach is that investigation of consciousness must always consider the whole system as a unity of *mind/matter*. We have shown that *speculative mind* (*Yin-Yang*) and *matter* (periodic system of elements and genetic code) have the same coding system. The link between *Mind* (as quantum field entity of empty space - *pure vacuum*) and *Matter* (as mass organized entities) are microtubules and their interaction with water. We believe, based on our knowledge, that human consciousness as mind/matter unity arises from this interaction. Considering this concept, together with Russel's idea about consciousness as a relation to an object in the sense of being conscious of something, we believe that human consciousness in some specific ways has expressed human being itself in the various works by different creative investigators through different epochs.

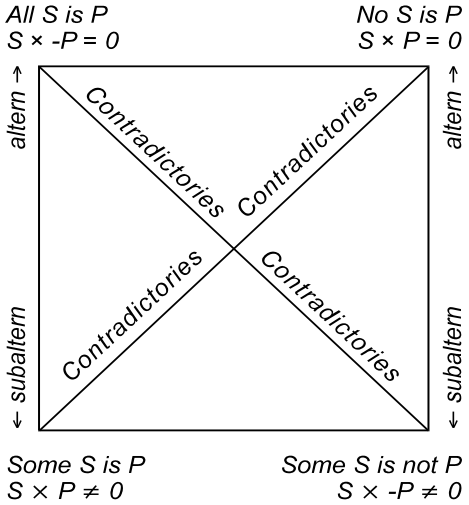


Figure 11 The universal consciousness on the universal code of Nature: Aristotle's syllogism "square of opposition" can be seen as specific Boolean logical square: No S is P (00), Some S is not P (01), Some S is P (10), All S is P (11) ... (cf. ref. [27], p. 341).

All the physiological (including biochemical and biophysical) processes of the human organism form the basis of human psychological and logical activities and all manifestations of consciousness. From the standpoint to be "conscious of" something, in this article we have shown that there exists a Universal consciousness about the universal code of Nature. This universal code as the basis of separate natural codes (chemical, genetic codes etc.) must be determined by Boolean spaces. Thus follows the hypothesis that human consciousness must also be determined by Boolean logical spaces.

This Boolean logical spaces concept of the universal consciousness must be provided by further investigation from different aspects. For example, from the aspect of an existing or not existing accordance with the quantum physics concept [28] and information physics [9].

Acknowledgments: *This research is dedicated to soul of Petar Petrović Njegoš (1813-1851), who wrote the poem "Light of the Microcosm" by emerging logic and Golden Mean laws.*

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BRAIN AND THOUGHT IN NEUROBIOLOGICAL CONTEXT

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Abstract. The study of biological foundations of mental processes and their relations with the somatic ones, within the thought-body or thought-brain relationship, certainly represents one of the most attractive domains of contemporary neurobiological science. Our research studies of the thought-brain relationship are within the three main hierarchical levels of the scientific disciplines concerned, enabling more exact insight into the problem in which we attempt to attribute some physical entity to the concept of *thought*, i.e. the entity not separated but being created by the brain - its cells and network of billions of pathways and connections. Those three hierarchical levels are: 1) the level of the nervous cell (neuron) and the subcellular organelles, including molecular organization as well, which is the subject of the contemporary *neurobiological studies*; 2) the level of the brain as an organ, which is studied in *neurological sciences* (neuroanatomy, neurophysiology, neuropathology, neurology ...) with the aim to explain the structure, function and characteristics of the neural connections and relations; 3) the level of human personality, which is the subject of studies in *psychological science or behavioral science* in the broadest sense (psychology, psychopathology, psychiatry, sociology ...). The analysis of the fundamental hypotheses in existing philosophical doctrines, monism and dualism, lead us to accept the *triunism* concept, which in our opinion offers new possibilities for the more exact materialistic formulation of the "thought" concept. In addition, it is emphasized that the contemporary biology, studying brain including human brain - its structure, mental capacities and physiological requirements - may be of help and represent a general base for the creation of new system of realistic biological, psychological and sociological targets of interest for the human well-being.

Keywords: *neurobiology, thought vs. brain, conceptual foundations, "triunism".*

Investigation of biological bases of the mentality and its relation to somatic, in the framework of thought-body and brain-body relationships and their coexistence in living organism, represents one of the most attractive domains of contemporary neurobiology. Numerous ideological doctrines today, as well as those in the past, gave a little contribution in formulating a clear concept and empirical investigation, the most confusing influences being imposed by ontological and metaphysical postulates. It is nonsense to raise the argument whether a mental state not related to the brain state exists or not, or whether mental events are causally influenced, if only one does not raise the question of the real meaning of the terms "mental state" and "mental event", which then includes a particular consideration of philosophical concepts of notions such as state, event and thought.

One of the initial postulates in these considerations is definition of human personality, which does not have consciousness-for-itself, but consciousness-about-

itself. We have sufficiently evolved from basic and minimal Kantian postulates in defining human personality ("personality is a subject responsible for its actions" and "personality is someone conscious of numerous identities of itself in different times"), especially in respect to personality-brain relationship. Our personality is not constituted of our face, body, extremities, and internal organs, we are composed of. Surgical removal of any such parts during illness or injuries does not change identity of human personality significantly. Also, by transplantation of organs (kidneys, heart, endocrine limbs) from one person to another, human personality does not suffer essential changes. What does represent material basis of human personality is not even the head as a whole, but the brain itself, or more precisely some of its parts. Surgical removal of some of brain's parts does impair some functions, but does not significantly influence the basic personality properties (e.g. removal of cerebellum impairs coordination of movements, but does not essentially change characteristics of personality). The part of brain most intimately related to human consciousness are cortical hemispheres, especially the dominant one (left in the right-handed and right in the left-handed). Serious personality impairments are registered in the cases of injuries or removal of dominant hemisphere. On the contrary, injury or removal of nondominant hemisphere, in spite of disturbances in motoric or some sensory functions of the opposite side of the body, does not significantly change the integrity of personality. (I have personally observed some patients with hemispherectomy of nondominant hemisphere and noticed the above observations.) For the sake of truth it should be noted that the functioning of hemispheres is seriously impaired in the cases of interruption of information flow from lower parts of central nervous system and environment, which normally generates necessary basis for activity and functioning of cerebral hemispheres (it is well known that damages of the brain stem, especially reticular formation, induce comatose states). In such situations, the objective indicator of the hemisphere functions (electroencephalogram) registers a drastic reduction or even absence of activity; personality is practically dead, in spite of partial functioning of some organs, supported artificially through external apparatus (artificial breathing, heart beating etc.). These several examples illustrate the standpoint that human personality is dominated by its brain, or more precisely by cerebral hemispheres, but not at all by other parts of human body, interconnected by nervous fibers with the brain, where functions of all parts of our organism are created, formed and modulated in respect to individual experience. Evolution of the human personality formation includes numerous phases of development, where genetic and environmental factors interact harmoniously, from embrional period to the adult personality. Our considerations of the thought-brain relationship are restricted inside three principal hierarchical levels of corresponding sciences, enabling a more exact articulation of the problem, where we try to relate thought to some physical entity, not divided from but created by the brain - its cells and networks of billions of pathways and interactions. These three hierarchical levels are (cf. Fig. 1):

(1) level of the nervous cell (neuron) and the subcellular organelles, including molecular organization as well, which is the subject of the contemporary *neurobiological studies*;

(2) level of the brain as an organ, which is studied in *neurological sciences* (neuroanatomy, neurophysiology, neuropathology, neurology ...) with the aim to explain the structure, function and characteristics of the neural connections and relations;

(3) level of human personality, which is the subject of studies in *psychological science* or *behavioral science* in the broadest sense (psychology, psychopathology, psychiatry, sociology etc.).

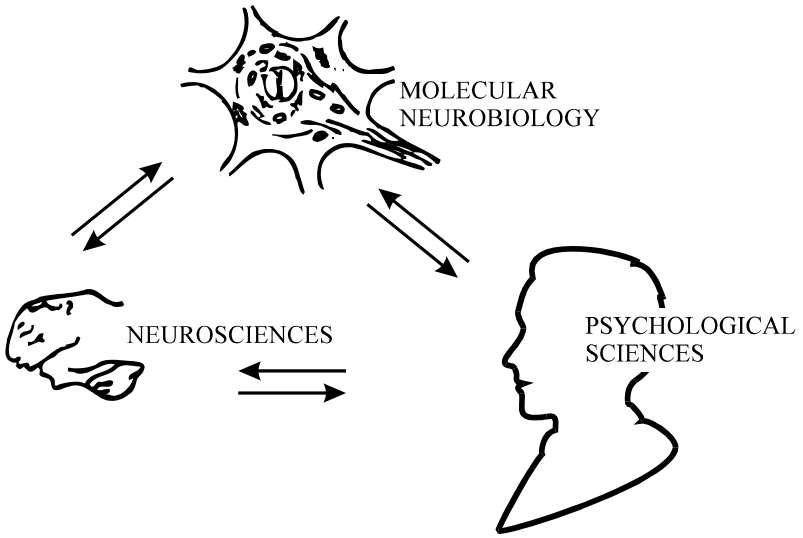

Figure 1. Three principal hierarchical levels, necessary for scientific consideration of the thought-brain relationship

All three levels are interacting dynamically, where molecular level influences the functioning of the brain level, and both of them together influence the psychological level in the widest sense of human personality and its most subtle manifestations.

Biological organization of organic matter expresses continual regeneration processes, implying constant transformation of material substratum of organism. For instance, the bones of infant change with growth their structure, strength, shape and chemical composition, depending on the intensity and direction of mechanical forces. Muscularity is changed depending on the degree of engagement. The human central nervous system consumes tenfold quantity of oxygen in respect to other tissues, as it has very active metabolism, including the intense protein synthesis. The neurons, contrary to the cells of other tissues, cannot be regenerated, but their

submicroscopic content and structure are continuously changing and regenerating, including release, acceptance and synthesis of different chemical compounds. The traditional concept of stability of the neuron is accordingly consequently reevaluated. Examples of this dynamic transformation of molecular organization and structure of a neuron are found in experiments related to investigation of biochemistry of learning and memory. It is known that learning in experimental animals is accompanied by increase of specific proteins in neurons (tubuline, C-100 protein etc.), heteromacromolecules (acide mucopolysaharides) and activity of numerous enzymes, especially in brain's structures and regions responsible for memorizing process. Short-range memory, related to direct reception of information, is localized in vicinity of contacting regions of the neurons (synapses), while long-range memory is related to engagement of systems localized in the nucleus of neurons (so called RNA-dependent mechanisms). The membranes of neurons which participate in such processes are specific morphological, biochemical and functional mosaic, different from other cells. Structural changes in synaptic membranes are under influence of: (a) pre- and post-synaptic areas; (b) changes in accepting, usage and releasing of numerous transmitters (chemical substances acting as mediators in transmitting nervous impulses from one to another neuron across the synapse); (c) variation in number, size and sensitivity of the so called reception cites; (d) structural changes in the so called synaptic gap; (e) modification in diffusion gradient and diffusion length of transmitters. The presence of heteromacromolecules at the membrane surface of neurons (glickolipides, glickoproteins, mucopolysaharides) seems to have principal role in the intercell signal recognition.

Dynamic complexity of the neuron activity is under the control of continuous influence of genetic determinants, metabolic and humoral factors, electrophysiological phenomena, received signals and many other factors which determine constitution, structure and functions of neuronal discharges and responses of larger neuronal populations - neural assemblies and higher structures. Most of these processes depend on genetically established mechanisms, automatic reactivities and information flow arriving from the environment. Automatic work of the respiration center, electrical coding of sensory information, and other complex neural operations do not depend on personal wishes. Moreover, these mechanisms are similar in cat and man. Hence, we do not possess exclusively those mechanisms which are similar in a large number of animal species. By not elaborating this problem any further, for us neurobiologists much more significant is the problem of investigation of origin, properties, temporal organization and evolution of different elements constituting a human being. What is that which remains constant, and that which changes during the whole life? Fingerprints represent permanent personal characteristic; personal experiences traced in memory are specific, although subjected to modification during the time; skills, also, can be learned, modified and forgotten; taste can be formed and changed; ethical orientations are under influence of social and other factors; beauty, also, can vanish. Is the person same in fifties and

fifteens, or as a newborn? What are those characteristics which are the basis of personal identity?

Most of these factors can be investigated using technology at disposal to contemporary neurobiology.

From the ancient times, the concept of brain-thought relationship was formed, globally, in the framework of confronted viewpoints of *monism* and *dualism*. On the basis of data presented in Table 1, these two viewpoints can be briefly summarized as follows:

(A) *Monism* emphasizes the existence of single entity. The extreme aspects of monistic doctrine are - everything is mental (phenomenalism, idealism) or everything is material (eliminative materialism). The less radical monistic theoreticians propose that thought and body represent only multiple aspects of the same entity (neutral monism), or thought is somatic (reducing materialism), or according to Bunge's theory (so called emergent materialism) mental states are formed on the basis of brain's states, although do not exist inside neurons or neural synapses.

(B) *Dualism* accepts entities, which are, depending on corresponding doctrines, either mutually independent, or have parallel existences tightly mutually bounded (psychophysical parallelism), or brain influences upon thought (epiphenomenalism), or thought controls the brain (mentalism), or thought and brain interact with one another (interactionism).

Table 1. *Monistic and dualistic approaches to thought-brain relationship*

A. Monism	**B. Dualism**
1. Everything is thought (phenomenalism, idealism)	1. Body and thought are independent
2. Thought is nothing (eliminative materialism)	2. Body and thought are parallel. (psychophysical parallelism)
3. Body and thought are in many manifestations or aspects the same entity (neutralmonism)	3. Body affects thought or masks it (epiphenomenalism)
4. Thought is somatic (reductive materialism)	4. Thought affects body or controls it (mentalism)
5. Thought is a sum of necessary somatic functions (emergent materialism)	5. Body and thought interact mutually (interactionism)

Our viewpoint is based on the proposal that thought is a unity of three basic structural elements, where absence of any one prevents existence of the very phenomenon of "thought", therefore being named triunism. The three basic structural elements are:

(1) Cerebral cells and pathways, which possess material and "transmaterial" properties, we shall talk about later.

(2) The flow of transmaterial information coming from environment, coded and transformed at the level of sensitive elements (so called sensory receptors), and formation of active parts of working brain, which modifies brain's anatomic structure and function.

(3) Visible manifestations which follow from p. (1) and (2), being expressed internally as a feeling, and externally as a behavior.

Triunism, also, presuppose dynamic, evolving interaction between structural elements of thought with temporal parameter, always oriented forwardly. It is clear that we cannot stop thought, and cannot investigate it separately from transmitting messages. The triunism concept, we emphasize, has a primary goal to stress biological basis of thoughts and to analyze the origin and role of constitutional elements in formation. In that context it is possible to investigate:

(a) occurrence and evolution of every mental function during the humanization process of newborn's brain;

(b) vanishing of mental fragments during brain's disorders;

(c) progressive loss of mental activities during the aging process.

During the lifetime of every individual, thought is emerging, evolving, changing and vanishing. In these processes every mental fragment can be in a different stage of development. So, the logical question emerges: how many mental functions (and how many of every kind) must be present to create thought? Is thought possibly less than normal in blinds, deafs or deaf-mutes, in sensory or culturally deprived children, in lobotomized patients or in microcephalic individuals? Might it be that such questions delude us, as it is extremely difficult to evaluate the whole thought and give advantage to some specific aspects which integrate it. It is certain that a blind person is deprived of visual aspects of mental activity, possessing physiological deficit in corresponding cortical centers (occipital cortex), midbrain (colliculus superior), interbrain (corpus geniculatum laterale) and other regions related to the vision analyzer, but this very person is able to compensate that through elevation of other mental functions, such as tactile and audio perceptions.

We all agree that thought is hard to locate, touch, measure or conserve in glass with formaline, which is possible with brain. Thought cannot be directly seen, but

their consequences, like mental activities, can be observed in the framework of heterogeneous qualities, such as consciousness, perception, intelligence, memory, emotion, and many other less defined entities. These functions are correlated with brain's anatomy and physiology, and their structural localizations within a brain are fairly well investigated. It is well known that brain possesses different structures responsible for corresponding functions and, according to dialectic concept, can be correlated with mental activities. In our opinion (designated above as *triunism*) this concept is valid only for developed brain of adults, but not for brain of newborns, as the brain immediately after birth has not and could not develop some functions necessary for appearance of thoughts. External information enters our senses, becoming material and functional part of adult's brain. The central nervous system, considered independently from their extracerebral constituents, cannot develop full functions. According to monistic viewpoint, thought has both material and functional unity, but in our opinion thought is represented by elements which follow from the three sources defined above, and without these elements mental functions cannot exist. In its essence, thought is a result of dynamical interactions of their structural components.

Definitions of notions *material* and *nonmaterial* are essential for understanding the notion of *thought*. Matter is most frequently defined as a set of elementary particles (electrons, protons, neutrons, mesons ...) which possess inherent properties of inertia, ability to be located in space and time, and which can interact mutually. Matter under decomposition releases energy. Cosmos consists of myriads of material objects.

Chemistry can be reduced to physics on the basis of quantum mechanical theory of chemical bonds, and biology is based on the complexity of physical and chemical organization of matter, possessing its own laws and new properties in creation. The existence and properties of material particles can be easily demonstrated experimentally, if researcher owes corresponding knowledge and instrumentation. But for those who do not possess adequate scientific education, discussion about electrons, protons, neutrons and mesons has no particular meaning.

In spite of our materialistic standpoints, solutions for a better understanding of higher psychological functions, including phenomena of thought and idea, cannot be sought inside mechanistic and vulgar materialism. It is clear that paintings of Picaso or Rembrant consist of material elements having properties of weight and inertia, but that very fact does not help us to understand artistic and symbolic senses of these works. We are far from any thought to seek for solution in metaphysical constructions and nonphysical forces, turning to nonmaterial concept which has today only emotional meaning, related to philosophical standpoints of religious and dualistic concepts of reality. Such "nonmaterial" entities are beyond the domain of experimental exploration and can be considered exclusively in the context of particular culturological, philosophical and theological concepts. Following the dialectic principle, but avoiding orthodoxies of vulgar materialism, which in failure

and impossibility to acquire objective exact proofs resorts to nonadequate ultimate postulates, such as known idealistic and religious concepts, we have regarded that in inquiring into the *thought-brain* relationship one should clearly distinguish two levels of entities:

(a) *Material entity*, in the above defined sense;

(b) *"Transmaterial" entity*, which is also unavoidable prerequisite of matter, being represented as a particular pattern of material organization, or as temporal or functional relationships of material substratum. It can exist conditionally outside the domain of existence of specific matter, as it does not possess original properties of matter based on our contemporary scientific measurements, such as mass and energy. However, we think that "transmaterial" aspects of reality, including material substratum, form, temporal and functional characteristics, could be and should be a subject of experimental research.

"Transmaterial" characteristics, such as symbols, information and meaning, are nor novel properties of matter, therefore being neither mutually interconnected by known anatomical organization nor being able to be expressed as a result of known natural, material characteristics, which in relationship with physiological functions demand spatial and temporal interconnections of experiences inside brain's organization of individuals. The pattern (model) gives a shape to matter, transmitting information without exchange of structure and energy. Material transmitter can influence the organization of other material transmitter, without changing any essential material characteristics of it. (For instance, the casting of gypsum figure in the porcelain model.) "Transmaterial" entities are transmitted materially, although being not necessary in connection with specific material transmitters.

This concept of "transmaterial" could be convenient for an understanding of transmission and processing of information inside brain, as it enables separation in research of mechanisms included in the sensory data flow up to central nervous system, transformation of messages through different systems, and then necessary decoding to understand the meaning for every particular perception and, therefore, for adequate reactive response.

The pattern detected by specific cortical neurons seems to be present in early individual experience. Experiments on chickens show that during the so called "critical period" (3-14 weeks after birth) their daily exposure to one hour in the environment with vertical lines causes the response of most cortical neurons specified for this type of visual stimulus (vertical lines). The complex of systems needed for some of these functions seems not to be necessarily preprogrammed by genetic factors, and presumably depends on information which, coming from the environment, bombards sensory cortical regions during postnatal ontogenetic development. Information received in this way is shaping the functional characteristics of neural systems.

The mechanisms for meaning recognition are insufficiently clear from the viewpoint of experimental neurobiology, although some models for explanation of that phenomenon do exist. According to Pribram, the received data are distributed throughout sensory systems, as an alphabet of spatial frequency-sensitive elements inside cortex, which receive visual information (so called occipital cortex). This alphabet is temporally grouped for specific recognitions. The parallel processing mechanism in some other cortical region (so called temporal cortex) initiates messages (categories) of alphabetical elements, being then programically organized through motoric structures (in cortex and basal nuclei), transmitting the elements in computer-like memory.

The received information, stored in brain in the form of memory or expressed by neurons as a recognition sample (so called "recognition-program-tape-model"), depends on the codes which circulate through brain cells and neural systems. To support this fact, let us recall the second element of *triunism*, given above - the flow of sensory information from the environment to individual brain. Suppose that these processes include simultaneously material transmitters and so called "transmaterial" coded symbols. We have previously pointed out that material was nonspecific element in receiver of sensory information, while coded symbols were specific messages, whose exact meaning could be expressed and transmitted through various transmitters, such as light, sound and shape. For instance, the notion "red" can be expressed in different languages, written by different means and materials, or represented by Morse alphabet. The meaning of this notion is independent of eventual material transmitter.

Several processes of the information transforming and different types of physical and chemical material transmitters are included in transmission of messages from some external source to their conscious perception by the brain, the every transmitter being at service of the same meaning. Those messages do not have weight or inertia; they can be neither dissolved to release energy, nor they possess any known property of matter. The meaning of messages has no essential existence, as in absence of decoding mechanisms and perceptive thoughts the symbols have no sense, in spite of possible existence of material transmitters. Or, for instance, in special orientation of magnetic domains on magnetic tape there is no sound or music unless particular velocity, amplification, and transformation in waves is not achieved to be heard by someone. Melodies must be created by transforming magnetic codes in acoustic pattern.

The codes, symbols and meanings do not exist by themselves or in process of generating properties of matter, but are results of intellectual correspondation (agreement) of human thoughts, based on an established system of relationships, individually learned by personal experience, which exceeds the limits of individual existence. Languages and letters were invented a long time ago, and will be used for many centuries in the future.

The symbols can be used not only by humans but also, as psychophysiological experiments show, numerous animal species. Cats, dogs and monkeys can learn, during conditional reflex procedures, that red light means punishment, and green some form of reward. The individual development consists primarily of acceptance and collection of symbols and approximate signs through life experience, in order to decode information received by our senses. Neurological processes are under the influence of "transmaterial" symbols of sensory perception, which are directing material structure of neurons. In these neurological processes there exists interaction between "transmaterial" symbols and material structure of engrams of memory. The usefulness of "transmaterial" concept is conditional, as it gives us support, a tool to inquire into the meaning and functioning of living matter. When we state that understanding of symbols is property of matter in creation (emergent property), although it might be true it cannot be of great advantage, as the existence of differences between material transmitters and "transmaterial" codes enable independent investigations of the elements involved. By conditional acceptance of "transmaterial" concept with full explanation, as stated above, we pose no doubt in our principal materialistic orientation. The orientation of our attention toward material mental activities in the context of three postulates of *triunism* mentioned above, represents, in our opinion and to our best knowledge, the way to express reality and support real materialistic explanation of the phenomena of thought and idea.

Thought can be hardly and possibly unnecessarily represented in the form of some integral definition. If we accept thought as a group of functions, built of elements which can be identified and explored, then we are able to use human intelligence and knowledge to closely explain mental capacities, by using known experimental techniques in brain research and finding correlation between brain's structures of newborns and adults. Maybe the aphorism "know thyself" could be replaced by another one, "use intelligence to make yourself better". As a newborn lacks experience to interpret sensory information, responsibility for forming its thinking is not a personal but a social problem. Brain functions presume reactive reception of information and patterns of various responses, which have mostly evolved during many centuries of human evolution. These elements of the past are shaping every individual brain, and individuals make the feedback influence on the environment, changing other brains and correspondingly their thought through existing and forthcoming generations.

Turning back to neurobiological aspects of the proposed *thought-brain* problem, we point out that thought without brain cannot exist. Without reception of sensory information, thought cannot be formed and expressed. Also, in absence of internal perception (feelings) and external motoric expression (behavior) thought cannot be recognized by other individual or by wider society. Symbolic, "transmaterial" aspects of information are materialized inside the human brain by changing anatomy (structure) and function of neurons. Reversely, the exchange

processes existing between codes and symbols, and neural substance, can reveal significant experimental data for understanding the thought-brain relationship.

The human values which represent cultural heritage of our civilization are in the widest sense "transmaterial" entities, whose expression demands the existence of matter. They can surpass the existence of particular materials, changing transmitters to keep its "transmaterial" properties, but they do not possess essential characteristics of matter like mass and energy. Personal material properties and material entities of humans, like muscularity, bones and brain, are of limited duration, related to human lifetime, while symbols, ideas and creativity can be permanent individual contributions to human culture. For that reason we are possibly slaves of old implanted ideas and mental patterns of the past generations. Some of the values from the history of civilization are now incompatible with the problems and realities of contemporary world, which sometimes can be the cause of crisis with unforeseen and disastrous consequences for the destiny of our planet. Correspondingly, one can raise the question of novel human and philosophical values and goals. Neurobiology, exploring the human brain, its structure, mental capacity and physiological needs, can help and become a common basis for creation of a new system of realistic, biological, psychological and sociological goals for benefit of humankind.

BRAINWAVES, NEURAL NETWORKS, AND IONIC STRUCTURES: BIOPHYSICAL MODEL FOR ALTERED STATES OF CONSCIOUSNESS

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Abstract. It is shown that neural networks with embedded "brainwaves" can cross the gap between the fast parallel unconscious mode of neuroscience and the slow serial conscious mode of psychology. The electromagnetic (EM) component of ultralowfrequency (ULF) "brainwaves" appears to enable perfect fitting with narrowed down limits of conscious capacity in normal awake states and very extended limits in altered states of consciousness - due to the biophysical relativistic mechanism of dilated subjective time base. It also enables the mixing of the normally conscious and unconscious contents in altered states, due to the relativistic Doppler mapping of the EM component of the "objective" ULF brainwave power spectrum on the zero-degenerate-frequency "subjective" one. An additional low-dielectric ($\varepsilon_r \approx 1$) weakly ionized gaseous neural network is necessary in these processes. This structure can be related to a displaced (from the body) part of acupuncture ionic system which can conduct ULF brainwave currents ~ 10^{-7} A, inside the conductive channels of the initial ionic concentration ~ 10^{15} cm^{-3}, with a tendency of deterioration during a period of ~ 1 hour. The ionized gaseous neural network, with embedded ULF brainwave currents, enables that "objective" distances can be "subjectively" optically recognized as much closer in altered states - due to the relativistic mechanism of the length contractions. Even some peculiar anticipating abilities of psyche are predicted in nonstationary ($\varepsilon_r \neq$ const) altered states during the interchange of normal and altered states of consciousness, due to the relativistic mechanism of time dilation (time warps) in highly noninertial "subjective" reference frame. All that provides an extraordinary biophysical basis for traditional psychology, including short-range and long-range transpersonal interactions and experiences down to the ultimate state of thoughtless consciousness. Notions, such as "qi", "subtle body", and "mental body", are physically inevitably associated with ions, displaced (from the body) part of acupuncture ionic structure, and in it embedded an EM component of ULF brainwaves, respectively. It should be pointed out that the above successes of the model finally provide possibility to incorporate consciousness inside an extended scientific paradigm, implying that consciousness is subtle internal display in the form of electromagnetic component of ULF brainwave ionic currents. The extended paradigm might have great influence on the fundamentals of neuroscience, psychology, medicine, biology, physics and computer sciences, with significant philosophical and religious implications.

***Keywords**: Brainwaves, neural networks, ionic structures, consciousness, biophysics, relativistic & quantum physics, theoretical model.*

1. INTRODUCTION

There is a curious traditional dichotomy between psychologists and neuroscientists. Psychologists work with the slow, serial, and limited capacity component of the nervous system, which is associated with consciousness and voluntary control, while neuroscientists work with the fast, parallel "hardware" of

the nervous system, enormous in size and complexity, and unconscious in its detailed functioning. But what is the meaning of this dichotomy? How does a serial, slow, and relatively awkward level of functioning emerge from a system that is enormous in size, relatively fast-acting, efficient, and parallel? That is the key question.

Such a question has been addressed recently by Baars [1]. He has developed a very detailed cognitive model of consciousness, proposing that the split between psychologists and neuroscientists in looking at the nervous system reflects the global-workspace architecture. Global-workspace represents a kind of working memory or central information exchange, whose contents can be "broadcast" to the nervous system of distributed modules as a whole, allowing many different specialized modules in the brain to interact, competing or cooperating for access.

There is strong evidence [2] that parts of the extended reticular-thalamic activating system (ERTAS) serve as major facilitators of conscious experience, whereas the cortex of the brain provides the content of conscious experience. In that process, novel or significant information is amplified in respect to other which remains unconscious.

There is, also, another neurophysiological evidence [3] concerning stimulus habituation experiments with monitoring event-related potentials (ERPs) in the brain, that global broadcasting is associated with consciousness. Prior to habituation it has been found that activity related to a repeated visual stimulus can be found throughout the brain; but once habituation takes place, it can only be found in the visual system. However, are ERPs only a reflection of collective neuronal activity, or may also be transmitters of information, embodiment of consciousness itself, or all that together?

Of particular note are, also, recent observations [4,5] of 35-75 Hz oscillations, that seemingly appear in association with regions of the brain involved with conscious attention. These seem to have non-local properties related to transmission of information throughout the brain, too.

Our theoretical model [6-8] implies that the electromagnetic (EM) component of ongoing activity (EEG) and evoked potentials (EPs) (henceforth brainwaves) can be even closely related to global broadcasting associated with consciousness. However, it is necessary that complete information (both conscious and unconscious) is permanently coded from brain's neural networks to brainwaves, presumably as brainwaves spatiotemporal patterns of the brain ionic structure [3], resulting from the integral temporal changes and activations of the synaptic interconnections in the neural networks of the brain. It is also understood that the informational content of the individual "ego" is simultaneously excited (from the brain's neural networks to the brainwaves) whenever new information is excited.

The model perfectly fits with the narrowed down limits of conscious capacity in normal awake state (when brainwaves are predominantly located in the brain

tissue with relative dielectric permittivity [9] $\varepsilon_r \gg 1$), and very extended limits in altered states of consciousness (REM sleep phase etc. [10], characterized by low-dielectric $\varepsilon_r \approx 1$ states in the framework of the model) - due to the biophysical relativistic mechanism of dilation of the subjective time base. It should be pointed out that purely biochemical mechanisms of the ERTAS (serving as a major facilitator of conscious experience, whereas the cortex of the brain providing the content of conscious experience, in the framework of Baars cognitive model [1]) cannot be accelerated up to several orders of magnitude in altered states, as compared to the normal awake state; however, they presumably affect ε_r, thus providing the bridge between biochemical and biophysical mechanisms.

In this review, details of the model will be presented, including brain's neural networks-brainwave interaction and information coding, extraordinary dilations of the subjective time base and mixing of normally conscious and unconscious contents in altered states, biophysical nature of low-dielectric ($\varepsilon_r \approx 1$) structure necessary for supporting the brainwaves in these states, biophysical basis of the traditional esoteric knowledge provided by the model, relationship between the quantum theory of measurement and consciousness, and independent experimental tests of the model.

2. A POSSIBILITY FOR BRAIN'S NEURAL NETWORKS - BRAINWAVE INTERACTION AND INFORMATION CODING

Information (thoughts) is presumably coded as brainwaves spatiotemporal patterns of the brain ionic structure [3], resulting from the permanent temporal changes and activations of the synaptic interconnections in the neural networks of the brain. These nonstationary brainwave patterns could be excited through one or more ultralowfrequency (ULF) channels [11]: $f_{o\gamma}^{obj}(30-50Hz)$, $f_{o\beta}^{obj}(13-30Hz)$, $f_{o\alpha}^{obj}(8-13Hz)$, $f_{o\theta}^{obj}(3{,}5-8Hz)$, and $f_{o\delta}^{obj}(0{,}5-3{,}5Hz)$, the first three of them predominantly corresponding to normally conscious states [12], and the last two corresponding to normally unconscious states [13]. The nonstationary brainwave ionic patterns are accompanied by the corresponding spatiotemporal patterns of electromagnetic (EM) waves, which is well described by Maxwell's equations of electrodynamics [14].

Most of the information processed in the brain's neural networks is normally unconscious, as only novel or significant information is passing the ERTAS threshold of consciousness, being emotionally and verbally modulated by nondominant (normally right) and dominant (normally left) cerebral hemisphere, respectively [15]. Amplified information is coded on three successive levels (neural networks, brainwaves ionic currents, and EM component of brainwaves) in

spatiotemporal form in γ, β and α channels; non amplified information is coded in θ and δ channels.

The existence of unconscious contexts during conscious processing of some information can easily be understood in normal awake states as overlapping process (during ~0.1 s [16]) of amplified (by ERTAS) brainwaves with conscious content and non amplified brainwaves with, therefore, unconscious contents, Fig.1(a). On the same line, contexts can become conscious in altered states of consciousness with ERTAS switched off (REM sleep phase [17], hypnosis [18], meditation [19], the psychedelic drug influence [20], some psychopathological states [21], and near-death experiences [22]), with extremely dilated subjective time base (Δt^{subj} » 0.1 s), when contexts contents are not more overlapped by previously existing normally conscious content, Fig.1(b).

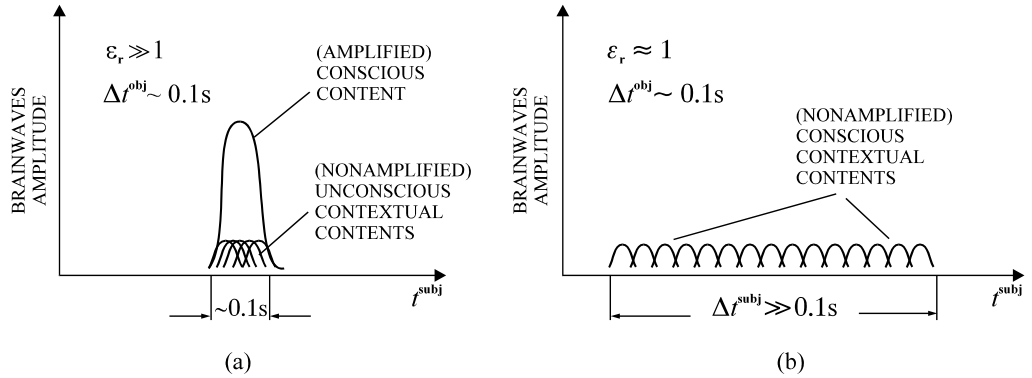

Figure 1 Schematic display of (a) overlapping process (during Δt^{subj} ~ 0.1 s) of amplified (by ERTAS) EM component of brainwaves with conscious content and non amplified EM component of brainwaves with unconscious contextual contents, in normal awake state (ε_r » 1), and (b) differentiated contextual contents, in altered states of consciousness ($\varepsilon_r \approx 1$), with extremely dilated "subjective" time base (Δt^{subj} » 0.1 s) - due to the biophysical relativistic mechanism of the model.

Alternatively, unconscious contents can be reached by consciousness when brain is tuned to ULF θ and δ channels, like in non-REM sleep phase, when these channels are significantly amplified, and the brainwaves spectrum is dominated by the slower waves of higher amplitude [12]. Naturally, one is aware of the unconscious information only in the non-REM sleep phase, forgetting it when the brainwaves shift to higher frequencies of the alert state - an exception being the information amplified to normally conscious level during the ERTAS awakening.

3. RELATIVISTIC MODEL FOR DILATION OF THE SUBJECTIVE TIME BASE

The only physical mechanism that can account for the extremely dilated subjective time base in altered states is the relativistic one [6-8], if only "subjective" observer can be associated with an EM component of brainwaves (and evoked potentials), which can move through the brain with relativistic velocities.[a)] In fact, the "subjective" reference frame is attached to the EM component of those brainwaves whose informational content refers to individual "ego" (or "self"); it is also understood that the informational content of the individual "ego" is simultaneously excited (from the brain s neural networks to the brainwaves) every time when new information is excited.

To be more specific, the ionic medium supporting propagation of the brainwave ULF ionic currents must be unhomogeneous, to ensure that the "subjective" observer (associated with the EM component of reference ULF brainwaves), moving through the part of medium of greater ε_r, could register time dilated information from faster EM component of brainwaves moving through the neighbouring part of medium of lower ε'_r (Fig.2; for further explanation cf. Eq.(1) and footnotes b and e). Then, at every moment the "subjective" observer is associated with the EM component of brainwaves in the dielectrically "denser" medium, and the whole such system behaves like some "center of consciousness". The informational content of such "subjective" observer is continuously replaced by a new incoming EM component of brainwaves. So, we have permanently some "stream of consciousness" [24]. More precisely, for inflowing information (in the form of ULF brainwaves ionic currents, coded in spatiotemporal patterns from the brain neural networks) to be recognized by the structured ionic medium, that medium itself must have a form of some kind of "optical" neural network - thus "subjective" observer being associated with the EM component of brainwaves in dielectrical "condensations" (of greater ε_r), behaving like "distributed centers of consciousness"!

By attaching the "objective" reference frame to the brain (i.e. laboratory) which moves relatively to the "subjective" reference frame with velocity [25]

[a)] In order to be able to attach the inertial observer to the EM component of brainwaves, it is necessary to show that the velocity of other EM waves is invariant (and equal c) in respect to the reference EM wave; this can be readily shown by applying the relativistic formula for the composition of velocities [23]: $(c - v)/(1 - vc/c^2) = c$, for $v = c_o/\sqrt{\varepsilon_r} \le c = c_o/\sqrt{\varepsilon'_r}$ (cf. Fig.2 for notations). Such an "subjective" observer (S_{subj}) would register all relativistic effects as any other object (equiped with instruments) moving inertially with velocity $v = c_o/\sqrt{\varepsilon_r}$ in respect to the brain (and the related "objective" laboratory reference frame S'_{obj})!

$v = c_o / \sqrt{\varepsilon_r}$ (where c_o denotes the propagation velocity of the EM field in vacuum, and ε_r the ULF relative dielectric permittivity of the denser ionic structure where brainwaves propagate), the relativistic relation between the time intervals [23], from the viewpoint of the inertial "subjective" observer ($v = c_o / \sqrt{\varepsilon_r} = \text{const}$), is [b)]

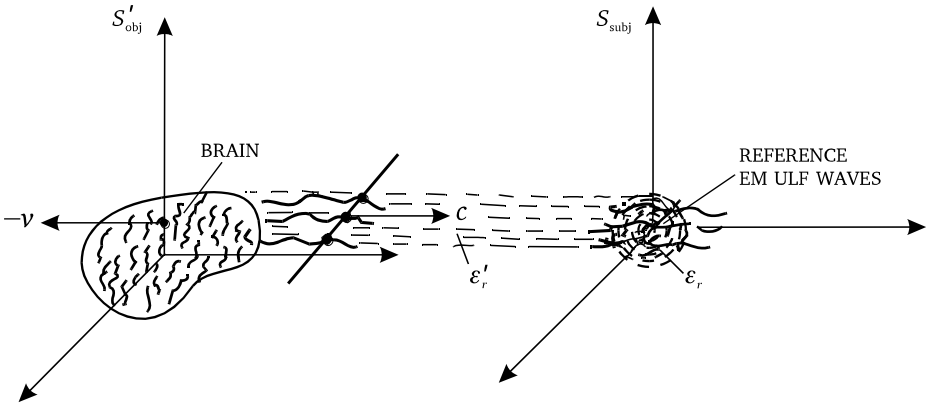

Figure 2 Figure accompanying the explanation for the necessity of the structured dielectric ($\varepsilon_r > \varepsilon'_r$) ionic medium, to ensure that the "subjective" observer (S_{subj}), related to EM field moving through the part of medium of greater ε_r, could register time-delated information from faster EM waves moving through the neighboring part of medium of lower ε'_r. More precisely, for inflowing information (in the form of EM field of ULF brainwave ionic currents, coded in spatiotemporal patterns from the brain neural networks) to be recognized by the structured ionic medium, that medium itself must have a form of some kind of "optical" neural network - thus "subjective" observer S_{subj} being associated with the EM component of brainwaves in dielectrical "condensations" (of greater ε_r), behaving like "distributed centers of consciousness"!

$$\Delta t^{subj} = \frac{\Delta t_o^{obj}}{\sqrt{1-\frac{v^2}{c^2}}} = \left.\frac{\Delta t_o^{obj}}{\sqrt{1-\frac{\varepsilon'_r}{\varepsilon_r}}}\right|_{\frac{\varepsilon_r}{\varepsilon'_r}\approx 1} >> \Delta t_o^{obj}, \qquad (1)$$

[b)] In Eq.(1) the velocity c necessarily corresponds to propagation velocity of EM field in dielectric medium (not in vacuum), as only in this case Maxwells equations in (homogeneous) dielectric medium (characterized by ε'_r) are Lorentz-invariant. In nonhomogeneous medium ($\varepsilon'_r < \varepsilon_r$), Eq.(1) can only be considered as approximation (of the general relativistic one), which can be considered satisfactory for linear dimensions of locally denser medium (of greater ε_r) significantly shorter in respect to linear dimensions of the neighbouring medium (of smaller ε'_r). Also, Eq.(1) does not apply to dielectrically homogeneous medium, where $\varepsilon'_r = \varepsilon_r$ (cf. footnote e). The same refers to Eqs.(2)-(3).

where $c = c_o / \sqrt{\varepsilon'_r}$ denotes the propagation velocity of the incoming EM field inside the neighbouring part of ionic structure with lower dielectric permittivity ($\varepsilon'_r < \varepsilon_r$, cf. Fig.2). This could account for the striking dilatations of the subjective time base (Δt^{subj}) in comparison with the objective time that measures the laboratory clock (Δt_o^{obj}), in altered states of consciousness.

The condition $\varepsilon_r / \varepsilon'_r \approx 1$ can be achieved only in a low-dielectric weakly ionized gaseous structured medium (with $\varepsilon_r \geq \varepsilon'_r \approx 1$), as the brain is a highly nonhomogeneous structure where ε_r could range from $\varepsilon_r > 2$ (characteristic of biopolymers) across $\varepsilon_r \approx 81$ (characteristic of free tissue water) to $\varepsilon_r \sim 10^5$ (characteristic of cell membranes, with striking polarization of the volume ion density within the porous cell wall, strongly depending on metabolic cell processes) [9]. Biophysical nature of the low-dielectric weakly ionized gaseous structured medium (with $\varepsilon_r \geq \varepsilon'_r \approx 1$) will be considered extensively later on.

The relativistic relation between the frequencies [26] measured in the two reference frames, moving away from one another ($\alpha = \pi$), is

$$f^{subj} = f_o^{obj} \left. \frac{\sqrt{1 - \frac{v^2}{c^2}}}{1 - \frac{v}{c}\cos\alpha} \right|_{\alpha=\pi} = f_o^{obj} \left. \frac{\sqrt{1 - \frac{\varepsilon'_r}{\varepsilon_r}}}{1 + \sqrt{\frac{\varepsilon'_r}{\varepsilon_r}}} \right|_{\frac{\varepsilon_r}{\varepsilon'_r} \approx 1} << f_o^{obj}, \qquad (2)$$

which describes the striking relativistic Doppler shift of the excited "objective" brainwave frequency (f_o^{obj}) down to the vanishing "subjectively" observed brainwave frequency ($f^{subj} \approx 0$ Hz) [c] in low-dielectric ($\varepsilon_r \geq \varepsilon'_r \approx 1$) altered states. This can account for the mixing of conscious and unconscious contents in the altered states of consciousness, as five main frequency bands of both the spontaneous (EEG) and evoked (EP) brainwave activities, $f_{o\gamma}^{obj}(30-50\text{Hz})$, $f_{o\beta}^{obj}(13-30\text{Hz})$, $f_{o\alpha}^{obj}(8-13\text{Hz})$, $f_{o\theta}^{obj}(3{,}5-8\text{Hz})$, and $f_{o\delta}^{obj}(0{,}5-3{,}5\text{Hz})$, the first three of them predominantly corresponding to normally conscious states [12] and the last two corresponding to normally unconscious states [13], for $\varepsilon_r / \varepsilon'_r \approx 1$ start merging from the viewpoint of the "subjective" reference frame: $f_\gamma^{subj} \approx f_\beta^{subj} \approx f_\alpha^{subj} \approx f_\theta^{subj} \approx f_\delta^{subj} \approx 0$ Hz, Fig.3. Although the "objective" brainwave power spectra in such states do not differ significantly from the spectrum of the alert state [27], the essential difference

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[c] This does not diminish the rate of "subjective" information processing, as this process is not serial but parallel (both in spatiotemporal and frequency domains), being enhanced on "subjective" level by greatly enlarged temporal resolution due to extremely dilated "subjective" time base in altered states of consciousness (cf. Fig.1(b)).

appears in the "subjective" brainwave power spectra; for the sake of comparison, in the alert state the brainwaves are predominantly located in the brain tissue (with ε_r » 1), when a differentiated "subjective" spectrum exists: $f_i^{subj} = f_{oi}^{obj}\sqrt{1-\varepsilon'_r/\varepsilon_r}\Big/\left(1+\sqrt{\varepsilon'_r/\varepsilon_r}\right)$, i = γ,β,α,θ,δ, cf. Fig.3.

This could be biophysical mechanism of *dreams*, which particularly implies their psychological significance: in dreams one has continuous access and more efficient "subjective" integration of normally conscious and unconscious contents, giving rise to integration and growth of human personality (otherwise divided into conscious and unconscious associative "ego" states), which results in alleviation of emotional conflicts!

So, one can state that there are two levels of information coding in brain-like conscious neural networks: spatio-temporal level of information coding (as the only one in contemporary artificial neural networks [20]) and ultralowfrequency level (which also exists in biological neural networks, and is responsible for conscious and unconscious states, according to the model).

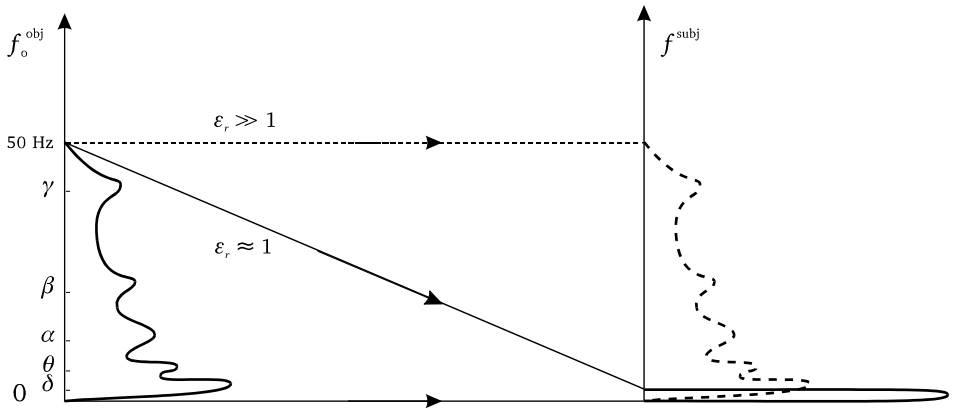

Figure 3 Display of Doppler mapping of electromagnetic component of the "objective" brainwave power spectrum on the "subjective" one, in psychologically altered states ($\varepsilon_r \approx 1$, solid line), and normal awake states (ε_r » 1, dashed line).

4. BIOPHYSICAL NATURE OF A LOW-DIELECTRIC ($\varepsilon_r \geq \varepsilon'_r \approx 1$) STRUCTURE

Now we shall consider biophysical nature of a low-dielectric ($\varepsilon_r \geq \varepsilon'_r \approx 1$) medium that supports the propagation of brainwaves in altered psychological states.

(a) That medium must be unhomogeneous, to ensure that the "subjective" observer (associated with the EM component of reference ULF brainwaves), moving through the part of medium of greater ε_r, could register time dilated information from faster EM component of brainwaves moving through the neighboring part of medium of lower ε_r' (Fig.2). Then, in every moment the "subjective" observer is associated with the EM component of brainwaves in the dielectrical condensations of the low-dielectric structured medium, with "distributed centers of consciousness". The informational content of such "subjective" observer is continuously replaced by a new incoming EM component of brainwaves. So, we have permanently some "stream of consciousness" [24].

(b) The low-dielectric medium must be gaseous [29] and weakly [30] ionized ($\varepsilon_r \approx 1$) to conduct ULF ionic currents, accompanied by an EM field - associated with the "subjective" observer. Also, it must be displaceable from the brain neural networks, but in mutual electrical connection to achieve the continuous inflow of information from the networks.

(c) For inflowing information (in the form of ULF brainwave currents, coded in spatiotemporal patterns from the brain neural networks) to be recognized by the weakly ionized gaseous structured medium - that medium must have a form of some kind of gaseous ionic "optical" neural network.

(d) For the EM component of brainwaves (and associated "subjective" observer) to be localized (not irradiated), brainwaves i.e. ionic currents must be ultralowfrequency ones - as intensity of the irradiated field is then extremely low (intensity I of the field of frequency f, irradiated from a dipole source of linear dimensions d, has a dependence $I \sim f^4 d^2$ [14]).

(e) The ionic concentration n_j in the channels of the weakly ionized gaseous neural network can be estimated by taking the average ionic drift velocity to be of the same order of magnitude as its thermal velocity [31], $\bar{v}_d = \left(3kT/m_j\right)^{1/2} \sim 10^3\ \mathrm{m/s}$ ($m_j \sim 10^{-26}$ kg is an ionic mass, and $k = 1.38 \cdot 10^{-23}$ J/K is the Boltzmann constant); then from the expression for the ionic current one obtains $n_j = I_o / e\bar{v}_d r^2 \pi \sim 10^{15}\ \mathrm{cm^{-3}}$, for the cellular dimension channel radius ($r_j \sim 1\ \mu$m) and brainwave ionic currents ($I_o \sim 10^{-7}$ A [32]). This ionic concentration is significantly lower than the molecular concentration in the air ($\sim 10^{19}\ \mathrm{cm^{-3}}$), which a *posteriori* implies that this gaseous structure is weakly ionized.

(f) One can conjecture that the biophysical basis of the low-dielectric weakly ionized gaseous "optical" neural network is the part of the acupuncture system displaced from the body, of an estimated ionic concentration $\sim 10^{15}\ \mathrm{cm^{-3}}$, carrying ULF currents $\sim 10^{-7}$ A. It should be pointed out that the displaced part has a significant tendency to deterioration, as the partial ionic pressure at room temperature (T ~ 300K), $n_j kT \sim 1$ Pa, is much greater than the magnetic pressure

which confines the channel [33], $\mu_o I_o^2 / 8\pi^2 r^2 \sim 10^{-10}$ Pa (μ_o= 12.566·10^{-7} H/m is the magnetic permittivity of vacuum).[d] Characteristic diffusion time τ for the ionic channel deterioration can be estimated as $\tau = L^2/D \sim 1$ h, where $D \sim 0.2$ cm^2/s is the diffusion coefficient under normal conditions in air [34] and L ~ r ~ 30 cm is the diffusion length estimated from the expression for the ionic current (from $I_o \sim 10^{-7}$ A is $n_j r^2 \sim 10^7$ cm^{-1}, and at the end of the deterioration process the ionic concentration of the channel reaches that one in air ~10^4 cm^{-3} [35], from where r ~ 30 cm).

(g) The obtained diffusion time of ~ 1 h matches well with the 90-120 minute ultradian rhythms of both waking conscious experience and nonREM-REM sleep alterations [36], and can be the cause of corresponding changes in subjective experience from normal to altered states (with extremely dilated subjective time base, and mixing of normally conscious and unconscious contents). In fact, referring to Figs. 1 and 3, it can be said that in normal state brainwaves propagate only through the structured brain tissue with $\varepsilon_r \gg 1$ (Fig.1(a)). On the other hand, altered states with extremely dilated subjective time base, and mixing of normally conscious and unconscious contents, are always accompanied by generation of displaced part of ionic acupuncture system with $\varepsilon_r \approx 1$ (Fig.1(b)), with ERTAS switched off. In the later case, brainwaves are propagating both through the brain tissue and displaced part of ionic acupuncture system, but conscious contribution of the first ones is negligible due to the overlapping of non amplified contents, while the second ones give rise to conscious contribution due to good temporal differentiation of the same contents. So, it seems that condition for existence of altered states of consciousness is both switched off ERTAS and generation of the displaced (from the body) part of acupuncture ionic system (the ERTAS switching off being presumably one of the trigger mechanisms for activation of some biochemical processes responsible for generation of displaced part of ionic structure). The first condition is, for instance, typically fulfilled in sleep, while the second one is then realized with a periodicity of ~ 90-120 min in REM-sleep phase, with abundance of dreams mixing the normally conscious and unconscious contents.

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[d] The stability condition would be fulfilled under equilibrium of the diffusion and magnetic pressures: $n_j kT = \mu_o I_o^2 / 8\pi^2 r^2$, where $I_o = e n_j \bar{v}_d r^2 \pi$. From these relations one obtains $n_j = 8kT / \mu_o e^2 \bar{v}_d^2 r^2 \sim 10^{24}$ cm^{-3}, for already used numerical data. It is obvious that this concentration exceeds by ~ 10^9 times that one in the displaced deteriorating ionic structure, and that greater would be the current I_o flowing through the ionic channels (I_o ~ 100 A), which is clearly incompatible with biological systems.

5. BIOPHYSICAL BASIS OF THE TRADITIONAL ESOTERIC KNOWLEDGE

It should be pointed out, quite unexpectedly, that the model provides an excellent biophysical framework for traditional esoteric knowledge, which will be clear from further analysis.

As a consequence of the deterioration process, the displaced part of the ionic acupuncture system can be finally "emitted" together with the informational content of the embedded ULF EM waves. Even the conditions for ULF EM field localization are not fulfilled at the end of deterioration process, as then ULF brainwave currents can flow through the surrounding weakly ionized ($\sim 10^4$ cm^{-3}) atmosphere, which significantly enlarges linear dimensions of the dipole source and therefore the intensity of irradiated ULF EM field. This can provide the biophysical basis for some extrasensory perceptions [37]: it is only necessary for phases of 90-120 minute ultradian rhythms of two persons to be matched, and exchanged information to be emotionally colored by ERTAS of receiver - which can explain why this phenomenon is mainly recognized between twins, mother and child, or otherwise closely related persons. Even long-range phenomena of this type are energetically supported by existence of extremely low attenuation at ULF frequencies due to "Schumann resonances" of the earth-ionosphere cavity, well matched with EEG-spectrum [38]. The above mechanism has probably been of adaptational significance for animal species, in highly efficient global spreading of surviving-important novel information [39]. Inside the human population, it seems that the Maharishi effect is providing evidence [40] for the above possibility - which can be biophysical basis of Jung's collective unconscious [41]. In that context, it could be said that ionosphere represents a dynamic collective memory of all biological species, which is continuously being refreshed by biological units with periodicity and phase of their ultradian rhythms.

Further deterioration of the points of displaced part of the ionic acupuncture system makes the whole ionic system homogeneous, without a possibility for new information to reach the subjective reference ULF EM component of brainwaves [e)], bringing the ultimate transpersonal state of thoughtless consciousness (*nirvana*, *samadhi*, *satori*, *enlightenment*, ... [43]). Objectively, the whole ionic system is completely open for information exchange in ULF domain, bringing a sense of oneness with the surrounding world, and subjectively, this is the state of empty consciousness, although the brain neural network can be still very active. This state elapses very shortly in nontrained persons, but can be presumably prolonged in

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[e)] In fact, the "proper time" ("subjective" time) for photons in dielectrically homogeneous medium is identically zero [42], this preventing any "stream of consciousness" (in contrast to situation for nonhomogeneous low-dielectric medium, when "subjective" time is highly dilated, cf. Fig.1(b)).

yoga-like trained persons. The lost part of the ions (of the initial concentration ~ 10^{15} cm^{-3}) is insignificant in comparison with that which exists in the body (~ 10^{20} cm^{-3} [44]), and can even be regenerated during the breathing process in ~ 1 h.

In the framework of the model, biophysical nature of the ultimate goal of yoga and related esoteric disciplines [43] is the prolongation of altered state to 24 hours a day, with displaced ionic system continuously opened. This means that ultradian rhythm does not exist any more, which can be achieved through the gradually enhanced functional connectioning of the left and right brain hemispheres (their prevailing dominance being normally governed by ultradian rhythm [45]). In prolonged altered state (yoga and related esoteric disciplines) one has continuous access and more efficient "subjective" integration of normally conscious and unconscious contents (cf. Fig.3), this being their major role in the growth of human personality. Finally, when displaced ionic system becomes continuously homogeneous it also becomes "objectively" opened to ULF interactions, achieving the continuous state of oneness with surrounding world (this being "subjectively" accompanied by the state of empty consciousness).

It should be noted that some peculiar relativistic effects are predicted by the model in spatial domain [23], in altered states of consciousness (when $\varepsilon_r/\varepsilon'_r \approx 1$):

$$\Delta l^{subj} = \Delta l_o^{obj}\sqrt{1-\frac{v^2}{c^2}} = \Delta l_o^{obj}\sqrt{1-\frac{\varepsilon'_r}{\varepsilon_r}}\Bigg|_{\frac{\varepsilon_r}{\varepsilon'_r}\approx 1} << \Delta l_o^{obj}, \qquad (3)$$

where Δl^{subj} is the length optically perceived by the "subjective" reference frame, and Δl_o^{obj} is the length measured in the "objective" reference frame. So, the weakly ionized gaseous neural network, with embedded ULF brainwave currents, enables that even long "objective" distances can be "subjectively" optically recognized as very close - due to the relativistic mechanism of the length contractions. Even more, such displaced ionic "optical" neural network can perceive an environment panoramically, which is reported by reanimated patients [22]. This can provide another type of extrasensory perception in optical domain, which is not limited by ultradian rhythms influencing the possibility for long-range interactions in ULF domain, as it was mentioned above (much higher frequencies in optical domain can be easily emitted and received, by the weakly ionized gaseous neural networks in altered states, at any time!).

Both of the transpersonal interactions mentioned above were of the long-range type. However, the model predicts also the short-range transpersonal interactions without any waves emitted, due to electromagnetic induction coupling between two neural networks with embedded ULF brainwaves. The situation is similar to that one in primary and secondary coils in electrical transformers, with the only difference that not only energy but also information is transferred from one neural network to another. This could be the biophysical basis for nonverbal hypnosis, suggestion, etc. which are

also not limited by ultradian rhythms, as there is no wave emission in the ULF domain. They are even possible in both normal and altered states of consciousness.

Even some peculiar anticipating abilities of psyche [37] can be presumably accounted by nonstationary states between the interchange of normal and altered states of consciousness (when brainwaves traverse from high-dielectric (ε_r » 1) to low-dielectric ($\varepsilon_r \approx 1$) state or *vice versa*, the relative velocity $v = c_o/\sqrt{\varepsilon_r}$ of "subjective" reference frame being subjected to abrupt change in short transitional period $\Delta t \sim 0.1$ s, with "subjective frame" acceleration $\sim c_o/\tau \sim 10^9$ m/s^2). Let us consider the nonstationary process as a superposition of two short stationary processes (both elapsing ~ 0.1 s, before and after interchange of states of consciousness), and one short nonstationary process of interchange of states of consciousness (elapsing ~ 0.1 s), cf. Fig.4(a). From the point of view of "subjective" reference frame, in normal high-dielectric stationary state ($\varepsilon_r >> \varepsilon'_r >> 1$) is $\Delta t^{subj} = \Delta t^{obj}/\sqrt{1-\varepsilon'_r/\varepsilon_r} \sim 0.1\,s$, and in altered low-dielectric stationary state ($\varepsilon_r \geq \varepsilon'_r \approx 1$) is $\Delta t^{subj} = \Delta t^{obj}/\sqrt{1-\varepsilon'_r/\varepsilon_r} >> 0.1\,s$. In transition from the normal high-dielectric ($\varepsilon'_r >> 1$) to altered low-dielectric ($\varepsilon_r \approx 1$) state (with striking "subjective frame" acceleration) is [46] $\Delta t^{subj} = \Delta t^{obj}\sqrt{1-\varepsilon'_r/\varepsilon_r}$, which has no real solution; but, any successive interaction of the low-dielectric ($\varepsilon'_r \approx 1$) displaced part of ionic acupuncture system with the high-dielectric (ε_r » 1) body [f] or any other surrounding non-low-dielectric (ε_r > 2) object - will give rise to real solution $\Delta t^{subj} = \Delta t^{obj}\sqrt{1-\varepsilon'_r/\varepsilon_r} \sim 0.1\,s$, with summarized Δt^{subj} >> Δt^{obj} for two short stationary processes and one short transitional nonstationary process (cf. Fig.4(a)). However, as the whole process is nonstationary and the "subjective" reference frame is noninertial, according to the theory of relativity [46] there *must* be $\Delta t^{subj} << \Delta t^{obj}$! [g] This can be achieved if only the "objective" time interval refers to one of the future "objective" reference frames ($\Delta t^{subj} << \Delta t^{obj}_{fut}$, cf. Fig.4(c)), i.e. if only "subjective" reference frame correlates with one of the future "objective" reference frames (not with the present "objective" reference frame!) in nonstationary altered states! Such "subjectively" recognized future information can be then transferred to the brain neural network, through continuously existing electrical connection

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[f] Actually, the electrostatic skin barrier imposes an restitutional attracting force for displacing part of ionic acupuncture system, this giving rise to successive interaction of the low-dielectric displaced part of ionic acupuncture system with the high-dielectric body.

[g] Let us remind ourselves of Einstein's "twin paradox", where - after cosmic trip with relativistic velocities - the slightly aged twin-astronaut reaches his grown aged twin-brother in the Earth. This is a cosequence of the accelerated relativistic movement of twin-astronaut in non-inertial reference frame, in respect to his twin-brother, who spent his life in the Earth inertial frame. In such a case, the time unequivocally elapses much more slovely in relativistic non-inertially moving reference frame, i.e. applied to the nonstationary altered states, $\Delta t^{subj} \ll \Delta t^{obj}$!

between the body and displaced part of ionic acupuncture system. The above analysis also implies that relativistic biophysical communication between "subjective" and present "objective" reference frames is forbidden during the interchange of states of consciousness!

Deeper understanding of physical mechanisms of (acausal) precognitive processes obviously sinks into the General theory of relativity, applied to highly noninertial reference frames (like in enormously strong gravitational fields, where similar phenomena are expected [47]). From the point of view of the General theory of relativity, physical processes in accelerated reference frame outside gravitational field and in that one inside gravitational field with equivalent (gravitational) acceleration - are identical (the so called Principle of equivalence, being one of the fundamentals of Einstein's theory of gravitation). Theoretical analyses show that in enormously strong gravitational fields the so called wormholes (or Einstein-Rosen space-time bridges) are created, whose entrance and exit could be in very distant space-time points. As in transitional states of consciousness the "subjective" reference frame, related to EM field of brainwaves, is subjected to quick change of velocity, with equivalent acceleration comparable with that one in enormously strong gravitational field of wormholes, according to the Principle of equivalence one could expect, in such brief states, the creation of Einstein-Rosen bridge and tunneling of "subjective observer", i.e. consciousness, in previously "mentally addressed" exit in space-time [h)] - reminiscences on passing through some tunnel being really reported by many patients reanimated from clinical death [22]! It should be pointed out that apart from the EM field, the displaced part of ionic acupuncture system (in the form of ionic neural network, having the "optical" sensory function) must also be tunneled in such (acausal) interactions of consciousness with distant events in space-time!

This could be a biophysical mechanism of the so called "astral projections" of consciousness [i)], those presumably being the basis of most psychic phenomena

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h) To support this, one can cite the technique adopted by "extrasenses" when they want to achieve some distant influence: they always intensely visualize the person or place, as mental targets! On the other hand, this could be deeply connected with the role of consciousness in quantum theory of measurement, where consciousness with its act of observation affects the final collapse of the initial wave function into one of possible probabilistic eigenstates - which implies that the collapse could be related with generation of local Einstein-Rosen bridge (see the next section, for more details).

i) Some theoreticians of gravitation have pointed out potential possibility of practically instantaneous trips in space-time by using wormholes, provided they are stabilized by so called "exotic matter", which pushes the wormhole's walls apart, (anti)gravitationally - as a consequence of the wormhole's negative average energy density, as seen by a light beam traveling through it (such anomalous kind of matter does really exist in strong gravitational fields, as the vacuum fluctuations near a black-hole's horizon are essentially exotic) [47]! The same mechanism, which can achieve space-time tunneling of displaced gaseous ionic neural network in transitional states of consciousness (invoking biologically induced gravitational anomalies in transitional states of consciousness, in general) by virtue of relatively weak ULF EM fields of brainwaves, $\sim 10^{-1}$ V/cm [9], reveals also possibility for tunneling more massive objects by using stronger ULF EM fields.

categorized in [37] (providing also explanation for transitional nature and difficult reproducibility of these phenomena)! In particular, reincarnation could be possibly traced as a result of the post-mortal mentally loaded (karmical) addressing of the deceased ionic structure: as a consequence, reincarnational cycles are to be expected between karmically related persons [j] - which is widely claimed in Eastern esoteric tradition [48]! In that process, the non-low-dielectric barriers in interaction with the non-low-dielectric deceased ionic structure are also inducing transitional states of consciousness, revealing that high-dielectric barriers are helping in overcoming themselves in these "astral projections" - quite opposite to normal experience in usual mechanical interactions [43]!

The predicted nonstationary altered states could also be the biophysical basis of anticipation [k] in intuition, precognition and deep creative insights [l] - which could be easily put under control by "mental addressing" on chosen problem, shortly before a waking-sleep transitional state! On awaking, the brain would then amplify the dream concerning the solution of addressed problem, giving to it the priority in respect to other processed information during the sleep phase. The information obtained in this way is usually mixed through associative coupling with other conscious and unconscious pieces of information during the following REM-sleep periods - having therefore some symbolic form, which has to be decoded through introspective analysis of the dream. Naturally, to solve some scientific, technical or artistic problem in this way, it is necessary for the person to be expert in the field, in

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However, a careful control of transitional states of consciousness, mental addressing, and necessary intensity of ULF EM field to amplify the effect - is needed. Presumably years of hard theoretical and experimental investigations will be necessary, but it seems that there are no fundamental obstacles in exploiting that mechanism for future fast space-time trips.

[j] Therefore, moral might be of ultimate practical significance for both individuals and civilization, especially taking into account that contents of our thoughts are presumably periodically emitted in ionosphere (with ultradian rhythmicity ~1.5-2 h, as mentioned above), further on influencing backward the human population globally. Such global information processing on the ionospheric level is enabled by inhomogeneities in its ionic structure due to local variations of the Earth magnetic field, implying that ionosphere behaves as a giant "optical" neural network, with ionic channels of greater conductivity in respect to local environment.

[k] According to the computer experiments with random number generators [49], only nonactualized possible futures can be anticipated (more accurately for *a priori* greater probabilities of their realization), in accordance with quantummechanical wievpoint, described in the next section.

[l] Even deep artistic experiences of spectators might have strong spiritual note - through spontaneous spectator's "addressing" on the masterpiece (exciting him in altered state of consciousness), and through it on the illuminating idea related to the artist in the moment of masterpiece creation. The same might apply to performers in performing arts. The whole situation arises associations on contacts with Plato's world of ideas - this being the world of virtual possibilities, according to our model (cf. foot note k). What is the physical nature of this world is still an open question, but one possibility is that it can be a world of ionic archetypic structures (astral world!? [43]) preshaping possible futures, described by wave functions Φ_i of "cosmic consciousness" (see the next section for further elaboration).

order to articulate the obtained solution in corresponding scientific, technical or artistic "language".

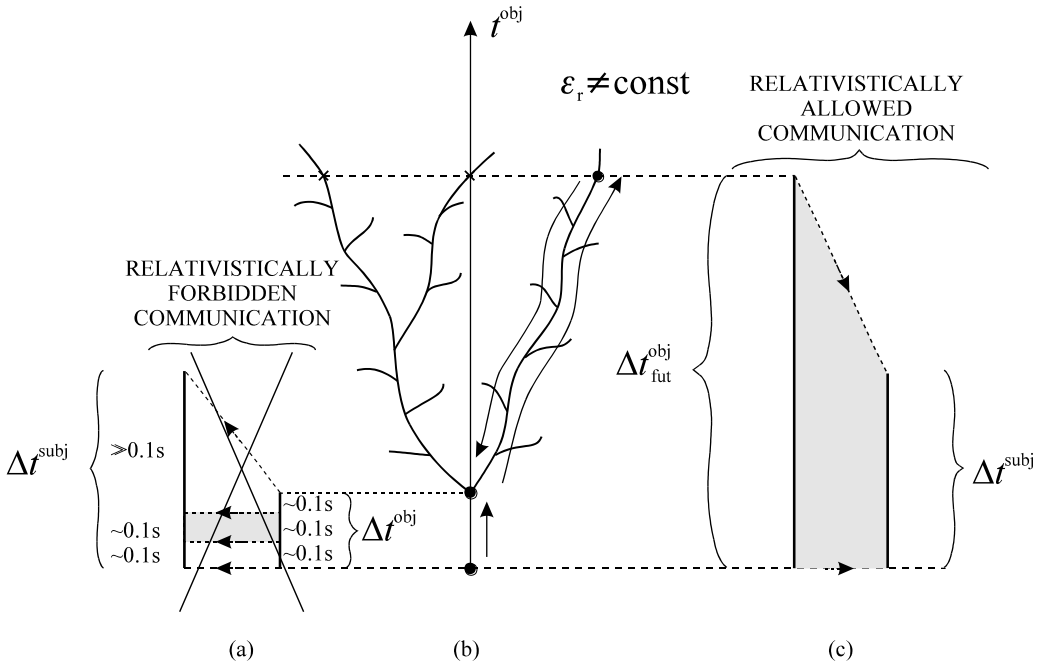

Figure 4. The schematic "subjective" view of relations between the "subjective" time interval (Δt^{subj}) and (a) the present "objective" time interval (Δt^{obj}), and (c) the future "objective" time interval (Δt^{obj}_{fut}), respectively, in nonstationary transitions from normal to altered states or vice versa (when $\varepsilon_r \neq$ const.). In Figure 4(b) the possible future alternatives are depicted; for relation to interpretation of quantum mechanics, see the next section.

It should be also pointed out that the ionic nature of the acupuncture system supports the possibility that ions in air (*prana*, *qi*, *pneuma*, *etheric vitality!?*) can be physiologically effective [35], just through the acupuncture ionic system and biophysical mechanisms that lie in the basis of acupuncture regulation [50] (out of them, the positive ions have an exciting influence (*yang!?*) and the negative ones an inhibiting influence (*yin!?*) [35]). So, qi (sometimes erroneously referred as a new kind of biological energy, *bioenergy*) can be related to ions flowing through the ionic channels of the acupuncture system in the form of ULF ionic currents, with informational content coded in spatio-frequency form of currents and EM fields. In support to the ULF nature of ionic currents in acupuncture channels, one can cite the resonance ULF (~ 4 Hz) stimulation of the acupuncture analgesia endorfin mechanism [51]. It should be pointed out that a lot of experimental phenomena related to external *qi gong* treatment [52] can be reconciled with (ULF) ionic nature of qi. So, it seems that the healing process can be related with the transfer of ions

between the healer and healee, and/or transfer of the EM information patterns responsible for normal functioning of acupuncture system and overall health. Also, the "astral projections" of displaced ionic structure in remote diagnosis and spiritual healing (including prayer addressed on ionically abundant disembodied archetype structures; cf. footnote d) [53,54] could be expected.

Also, it seems that esoteric notions such as *subtle body* (*manomaya, lingasarira, manovijnana, ka, psyche, astral body, psychic body,* ...) and *mental body* (*vijnanamaya, suksmasarira, manas, ba, thymos, mind, noetic body,* ...) [43] are biophysically inevitably associated with a partly displaced (from the body) ionic acupuncture system, and an EM component of ULF ionic currents embedded within it, respectively. On that line, the ionic condensations in the structured acupuncture system, with an EM component of ULF ionic currents embedded within it, behave like "distributed centers of consciousness" - this presumably being biophysical basis of yogic *chakras* [43].

Finally, if the EM field of ULF ionic currents represents sophisticated internal display (related to consciousness) of neural network information processing, it seems that consciousness is not privilege of humans - but can be also a characteristic of higher animals. Even more, if microtubular cytoskeletal structures have neural network-like electrical activities on subcellular level [55], it seems that consciousness can be descended down to the cellular level of animals and plants, which is supported by some experiments in a past few decades [56]. Naturally, the conscious content displayed in such EM internal displays depends on the complexity of corresponding neural network information processing at different levels, from cellular to brain ones.

Furthermore, as the EM field is presumably only one out of four manifestations (electromagnetic, gravitational, weak and strong nuclear forces) of the unified physical field [57], it can be tentatively generalized that the unified field itself may be internal conscious display for various physical processes at different structural levels, from macroscopic cosmic to microscopic subnuclear ones. As a consequence, one could conjecture that Nature itself has consciousness at different structural levels, both animate and inanimate, as it is widely claimed in traditional esoteric knowledge [40,43]. Although such nonlocal pantheistic idea of consciousness is rather bizarre, it can naturally help in resolving the fundamental problem of the wave function reduction in the quantum theory of measurement.

6. QUANTUM THEORY OF MEASUREMENT AND CONSCIOUSNESS

Consciousness as a physical phenomenon appeared for the first time at the begining of this century, with discovery of Quantum mechanics. In quantum theory of measurement there appeares the problem of the wave function reduction

(collapse), where in an act of measurement (including finally the very act of conscious observation [m)] of the act of measurement) the macroscopic measuring apparatus (including consciousness as a "subjective" observer) makes reduction of the initial wave function into one of the possible eigenfunctions of the system.

The problem of the wave function reduction (collapse) in an act of measurement is "ortodoxly" interpreted in quantum theory of measurement [58] as the discontinuous change induced by the observation of a quantity with eigenstates $\Psi_1, \Psi_2,...$, in which the initial wave function $\Psi = \sum_i a_i \Psi_i$ will be changed to the state Ψ_j with probability $|a_j|^2$. The collapse of the wave function and the assignment of statistical probabilities do not follow from the Schrödinger equation - they are consequences of an external *a priori* metaphysics, which is allowed to intervene at this point and suspend the Schrödinger equation, or rather replace the boundary conditions on its solution by those of the collapsed state function.

The problem of quantum theory of measurement has not been consistently resolved to date, and has been the subject of many serious theoretical efforts, from the very beginning of Quantum mechanics [58-60].

On the other hand, Quantum mechanics is *nonlocal theory*, as even very distant parts of quantummechanical system (which cannot exchange light signals) can be physically correlated in the act of measurement (like in Einstein-Podolsky-Rosen paradox [59]). As an extreme consequence, this implies that consciousness as a "subjective" observer in such kind of experiment must have *nonlocal properties*.

The property of *nonlocality* of consciousness is *automatically fullfiled* in our relativistic biophysical model, according to which consciousness is inherently and globally related to the very *electromagnetic field* of the brainwaves ionic currents! Having in mind that EM field is only one of the four manifestations of the unified physical field [57] - it might be that the very *unified field* is global (nonlocal) internal conscious display for various physical processes at different structural levels, from microscopic to macroscopic ones. This bizarre nonlocal pantheistic idea of consciousness can naturally help in resolving the *fundamental difficulties* of the *wave function reduction*, as stated below.

In one of the most recent approaches, Penrose proposes gravitationally induced wave function reduction [60]. Actually, the gravitational field of measuring apparatus, with all possible measuring outputs, must be also involved in the above

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[m)] Radical proponents of such a standpoint were von Neumann [58] and Wigner [59]. One should mention also the paradox of Schrödinger's cat [59], with cat in a closed box equipped with radioactive α-source, whose α-emitting activates a chemical poison in the box. The cat's state ("cat dead" or "cat alive") depends not only of statistical activity of radioactive decay of the α-source, but of the very observational act of conscious observer after opening the box: until this very point, the cat was in the quantummechanical limbo of simultaneous combination of "cat dead" and "cat alive", with different relative probabilities depending on the probability for α-decay of the radioactive source.

superposition of quantum eigenstates - this implying different space-time geometries superimposed. However, when the geometries become sufficiently different (on the Planck-Wheeler scale ~ 10^{-35} m), thus implying ill-defined standard superposition of the *matter* eigenfunctions in strictly *separate* spaces - Nature must choose between one of them and *actually* effects wave function reduction.[n)]

As an opposite extreme in interpretation of the act of quantum measurement, Everett's many-worlds interpretation of Quantum mechanics [59] proposes that no collapse of initial wave function is happening in the process of measurement, but that there exists splitting of the composed initial state, consisted of initial state Y and the apparatus state Φ, into the superposition of all possible composed states, consisted of eigenstates Ψ_i and corresponding observers states Φ_i, $\Psi\Phi = \sum_i a_i\Psi_i\Phi_i$ - each element of the resulting superposition describing an observer who perceived a definite and generally different result, and to whom it appears that the initial state Ψ has been transformed into the corresponding eigenstate (Ψ_j, if particular observer's state is Φ_j). In this sense the "popular" assertion of the wave function reduction appear to hold on a subjective level to each observer described by an element of the superposition. The price to be paid for physical consistency - is the splitting of the initial system into many copies with different eigenstates, existing simultaneously further on.

Actually, all that consistently applies to the whole Universe, which is constantly splitting into a stupendous number of branches, all resulting from the measurement-like interactions between its myriads of microparticles. In the context of our biophysical model of consciousness, different "subjective" states of delocalized "cosmic consciousness" can be related with corresponding observers

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[n)] The completely consistent physical picture of such a process (related to Planck-Wheeler scale) should be sought in future quantum gravity theory [60]. One of particular approaches to quantum gravity was confronted with computationally unsolvable topological equivalence problem for 4-dimensional space-time geometries, which is then related with ill-defined decomposition of quantum-gravitational state on superposition of all possible space-time geometries. The another related problem is that in such quantum-gravitational superposition one must superimpose, alongside the "reasonable" space-time geometries in which time behaves fairly sensibly, "unreasonable" space-times in which there are closed timelike lines (time travel in own past; it should be noted that such solutions are obtained from classical Einstein's gravitational equations too, as so called wormholes or Einstein-Rosen space-time bridges, mentioned in previous section [47]). Such bizarre space-time geometries are acausal (the cause and consequence exchange their roles!), and hence cannot be algorithmically simulated [60]. As, according to Penrose, the solving of quantum measurement problem is prerequisite for an understanding of consciousness, the consciousness itself cannot be algorithmically simulated (which is additionally supported by Gödel-Turing argument that human understanding and creativity cannot be modeled by Turing machine, i.e. they cannot be reduced to computer algorithm) [60]. However, this does not necessarily means that future brain-like computers with artificial consciousness are not possible: they can be based on biophysical principles we human beings are functioning, but they certainly will not be similar to contemporary algorithmic computers.

states Φ_i - associated with corresponding cosmic eigenstates Ψ_i, with different probabilities $|a_i|^2$.

It should be noted that physical interaction of the displaced gaseous ionic "optical" neural network with *possible* "objective" system (described by wave function Ψ_i) or corresponding *possible* state of "cosmic consciousness" (Φ_i), in "astral projections" during transitional states of consciousness - opens a question on the nature of wave functions - which should provide a picture of quantum-level physical *reality* (not only serving as a calculational device, useful merely for calculating probabilities, or as an expression of the experimenter's "state of knowledge" concerning physical system)! Then by changing initial state of "cosmic consciousness" (Φ) one can influence probabilities of realization of corresponding states Φ_i, i.e. cosmic states Ψ_i. As the state of "cosmic consciousness" (Φ) is a composite state constituted of (noninteracting) states of all "individual consciousness" (φ_k), $\Phi \sim \prod_k \varphi_k$, it follows that the change of state φ_k of "individual consciousness" can affect the state Φ of "cosmic consciousness", and therefore the probabilities for realization of cosmic states Ψ_i. This is particularly true if the state Φ is very sensitive on small changes of initial conditions, which is the case for physical systems described by deterministic chaos [61]. Having in mind that the brain and corresponding state φ_k of "individual consciousness" is such kind of system, then the composite state Φ of "cosmic consciousness" is also described by deterministic chaos - and therefore very sensitive on small changes in initial conditions! Such a conclusion implies extraordinary practical significance of moral and contents of our "individual consciousness", as they directly determine the probability of realization of cosmic states Ψ_i, i.e. the future events, no matter how bizarre this conclusion looks like (see also the footnote j)!

Moreover, as microparticles are continuously subjected to fantastic accelerations ($\sim v^2/r \sim 10^{23}$ m/s^2 for electrons bounded in atoms, and $\sim 10^{29}$ m/s^2 for protons and neutrons bounded in nucleus,...), which can be met also in extremely strong gravitational fields - according to the Principle of equivalence one should expect continuous opening and closing of local Einstein-Rosen bridges, addresses of their exits being related (probabilistically) to one of the possible eigenstates of corresponding microparticles.[o)] This process might yet be the mechanism for some sort of the wave function reduction, implying why so important the *mental*

[o)] The necessity for application of quantum mecanics to phenomena related to Einstein-Rosen bridges (wormholes) is also pointed out in analyses of indeterministic trajectories of classical bodies moving through a wormhole (due to possible backward mechanical influence of the body on itself, after getting out from the nearby wormhole's exit appropriately placed in the past in respect to the wormhole's entrance, for the same initial conditions there can potentially be many trajectories of the body through the wormhole, obeying classical conservation laws) - with corresponding probabilities for any of them, as in the case for quantummechanical microparticles [47]!

addressing is in transitional states of consciousness, related to "astral projections", described above! It also reveals that Quantum mechanics and the General theory of relativity seem to be deeply interconnected on microparticle level, showing that microparticles are continuously vanishing and reemerging (subjected obviously to corresponding conservation laws) in measurement-like interactions, throwing a new light on wave-particle dualism and other quantummechanical phenomena.

In that framework, the role of consciousness in quantum theory of measurement turns out to be extremely important! For instance, in gravitationally induced wave function reduction, the very mechanism for this process could be continuous opening and closing of local microparticles' Einstein-Rosen bridges, addresses of their exits being related (probabilistically) to one of the possible eigenstates of corresponding microparticles - and everything being related to corresponding probabilistic addressing of delocalized "cosmic consciousness" (including the state of the measuring apparatus). On the other hand, in the framework of many-worlds interpretation of quantum mechanics, many different local Einstein-Rosen bridges could be simultaneously created, related to corresponding observer's states Φ_i of delocalized "cosmic consciousness" - associated with corresponding world's eigenstates Ψ_i. [p)]

7. PROPOSED EXPERIMENTAL TESTS

It should be noted that psychological tests on subjective time sense distortions in altered states are not sufficiently distinctive, being affected by at least two effects: (a) amount and complexity of the processed and memorized stimuli (limited by "channel capacity" of conscious information processing, of one piece of information

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[p)] Which of these opposite viewpoints will turn out to be closer to reality is not at all clear. However, my personal feeling is closer to the first viewpoint, with gravitationally induced wave function reduction of the kind described above, where adjustment of the state Φ of "cosmic consciousness" to one of its eigenstates Φ_i, during the measurement-like process on cosmic scale, raises the corresponding probability $|a_i|^2$ to 1, while diminishing the others - by creating corresponding local microparticles' Einstein-Rosen bridges throughout the Universe, giving rise to existence the cosmic state described by corresponding wave function Ψ_i. What is actually anticipated in transitional states of "individual consciousness" might be the evolved state $\Phi(t)$ in some future moment t (to which our "individual consciousness" has access, being the constitutional part of "cosmic consciousness"), which is quantummechanicaly described by deterministic unitary evolution governed by Schrodinger equation (or Dirac equation in relativistic case). However, the anticipated state $\Phi(t)$ could be redefined by changing initial state φ_i of "individual consciousness", leaving room for *free will* and the possibility for influence on the future. In this respect, it is quite possible that strong *preferences* in individual or collective futures exist, governed by karmical interpersonal loads, as it is claimed in Eastern tradition [48]. On the same line, it might be also possible that karmical cleansing (by prayer or some other esoteric technic) is the efficient mechanism for changing initial state of several (karmically) related "individual consciousness" [53,54].

per ~ 0.1 s) [62], and (b) the relativistic model for dilations of the subjective time base, i.e. "channel capacity" (influenced by change in ε_r from $\varepsilon_r >> 1$ to $\varepsilon_r \approx 1$).

However, there are still some possible tests of our model:

(1) The insufficient change in the biochemical rate of neurotransmitter secretion in altered states in comparison to normal alert state can be tested by positron emission tomography. This can demonstrate insufficiency of purely biochemical methods, and the necessity of adopting the proposed biophysical method, in explaining the striking acceleration of conscious information processing in altered states in respect to normal ones.

(2) The detection of the low-dielectric ionic structure, partly displaced from the body in the altered states of consciousness, is possible by monitoring the local change in the ionic concentration (from 10^4 to 10^{15} cm^{-3}) in the vicinity of the body, by using infrared image processing, microwave scattering, electro-photography, positron emission tomography or some other isotope tracer studies.

(3) The information coding from neural network to brainwaves can be tested on artificial or biological neural networks with embedded ULF electric activity. It is only necessary to learn the network to some complex stimuli, or conditioned reflex in the case of living organisms. If this information is simultaneously coded in ULF electric activity, it can be transferred to neighbor equivalent neural network due to electromagnetic induction coupling. This could demonstrate the possibility for neural network-brainwave coding and vice versa, as well as the mechanism of short-range transpersonal interactions.

(4) Transpersonal long-range EM ULF biophysical interactions predicted by the model can be tested between the close persons with synchronized 90-120 min-ultradian rhythms, at the end of phases of altered states of consciousness.

(5) On the contrary, the predicted transcendence of space-time relations in precognitive or clairvoyant (acausal) phenomena, with non-EM ULF wave transmission, can be tested during the short phases of interchange of normal and altered states of consciousness.

8. CONCLUSION

Our biophysical analysis of the serial conscious psychological mode in normal and altered states of consciousness, implies that consciousness is subtle internal display in the form of electromagnetic component of ULF brainwave ionic currents. An additional low-dielectric ($\varepsilon_r \approx 1$) weakly ionized gaseous neural network is necessary in these processes, with the possibility of partial displacement from the body, and subsequent deterioration.

This can emulate many of the altered states of consciousness described by traditional esoteric knowledge, and reveals the probable biophysical nature of dreams, yoga goals, qi, subtle body, causal body, short-range and long-range transpersonal EM ULF interactions, and anticipating and clairvoyant acausal abilities of psyche - in the framework of the proposed theoretical model.

The model also implies that consciousness, space, time, and structure of matter might be much more deeply interconnected than it was recognized by contemporary science - quite contrary to ancient civilizations, which realized and exploited that on purely empirical grounds.

It should be finally pointed out that the above successes of the model provide a possibility to incorporate consciousness inside an extended scientific paradigm. The extended paradigm might have great influence on the fundamentals of neuroscience, psychology, medicine, biology, physics and computer sciences, with significant philosophical and religious implications.

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