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Regulatory Systems and Values[*]

From the view of Neuroscientist

Abstract

The advances in the neurosciences in the Last decades have significantly contributed to our basic understanding of brain structure and function, and consequently to insights into the functioning of both the normal and damaged human brain. This has spurred new developments in numerous disciplines in the natural as well as social sciences and provided 111 impetus for solving fundamental dilemmas of contemporary science and social with profound implications for or the future of man.

Values are human constants of critical importance for the functioning of social communities, for creation of striking personal orientation. Value statement do not describe by social facts but from the attitude of a person in relation to these facts.

Changes in philosophical concepts have occurred much more slowly than in the natural sciences. Modern philosophic concepts (both positivitistic and Marxist) rely upon the results of brain research to answer questions relating to man as a natural being or entity above nature, who changes her course, to the relation of man to the world he lives in, to the relation between the natural and social sciences, and to how the nervous system reflects nature.

Unable to nuke more detailed analysis of these questions, we shall here restrict ourselves to a presentation of some neurobiological features of values; the relation of man to his environ me nr; metodologic problems in the study of the hierarchic organization of the brain; questions con-

[*] The paper is printed as submitted.

cerning the relation of the neurosciences to Prigogine's idea of „new alliance" between man and nature; and transfer of concepts from the natural to the social sciences.

By discovering biological mechanisms which may describe the overall potential of the brain, and which may become expressed under the influence of exogenous factors, neurobiology had opened up many new problems which extend well beyond its own domain.

1. Introduction

The advances in the neurosciences in the last decades have significantly contributed to our basic understanding of brain structure and function, and consequently to insights into the functioning of both the normal and the damaged human brain. This has spurred new developments in numerous disciplines in the natural as well as the social sciences, and provided an impetus for solving fundamental dilemmas of contemporary science and society with profound implications for the future of man.

The conviction is now increasingly shared that it is not merely useful to identify trends and predict the likelihood of potential events, it is indispensable. As this magnificent yet terrible century has repeatedly demonstrated, without keener foresight and more responsible planning, many highly favorable possibilities will t>e missed. Furthermore, current policy may have regrettable and perhaps even disastrous consequences, which could evolve so quickly that man would be powerless to protect himself from them.[1]

Looking at the future is thus an onerously serious undertaking. The development of new analytic capabilities, new institutional forms and new outlets for expression as well as a steady growth in actual funding have all contributed to making the study of the future an endeavor preoccupying a growing number of people throughout the world. Methodologic advances have greatly contributed to our understanding of pathological processes, and as J. M. R. Delgado* has pointed out: „the attempt to understand ourselves, the conception of our own personality, the investigation of the elements which structure our identity and of the options and consequences of our behavior, arc essential features of human beings."

However, changes in philosophic concepts have occurred much more slowly than in the natural sciences. Modern philosophic concepts (both positivistic

and Marxist) rely upon the results of brain research to answer questions relating to man as a natural being or entity above nature who can change her course; the relationship of man to the world he lives in; the relationship between the natural and social sciences; and the relationship between the nervous system and nature.

Although all these questions deserve a detailed analysis, we shall restrict ourselves in this paper to the consideration of some neurobiologic features of values; the relation of man to his environment; methodologic problems in the study of the hierarchic organization of the brain; questions concerning the relation of the neurosciences to Prigogine's idea of the „new alliance" between man and nature; and transfer of concepts from the natural to the social sciences.

2. The Relationship between Man and His Environment

This is comprised of three basic issues. The first relates to *ontological* questions of being and existence. Traditional ontology studied existence in isolation, contemplated the world as it is apart from man and human consciousness. Marxist philosophy approaches ontological problems differently: the objective world must be considered in relation to human practice in the broadest sense, including not only physical activity performed by humans, but sensory perception, symbolic mathematical operation, logical conclusions and intuitive reasoning as well. Therefore, according to Marxist philosophy we in fact study the *human* world as limited by human capacities, transformed by human action, comprehended in the light of human needs, using technical instrumentation and conceptual and linguistic apparatus humanly developed. 3

The second group of basic philosophic issues consists of *gnoscologic* problems: how we acquire knowledge and how we ascertain whether cognition coincides with reality. There have been many attempts to idealize and absolutize the process of cognition and in this way to dehumanize it. Knowledge has often been viewed separately from human consciousness: as absolute truth independent of man, and universal logic as a structure similar to reality. The humanistic theory of knowledge makes these questions irrelevant. Philosophers can discuss only human knowledge, the logic of human thought. The structure of reality is inevitably simplified, and truth is accordingly seen in an historical context, subject to subsequent reconsideration. Whenever philosophical aspirations arc higher, they attribute absolute meaning to the limited

and relative knowledge of man, and only succeed in guarding against future improvement.

The third group of basic philosophical issues is composed of axiological problems: which alternatives we should choose to strive for. Ever since its origin, axiology has been primarily treated as a theory of absolute and transcendental values which can be taken ideally, regardless of actual human behavior. Marxists have, in general, avoided dealing with the problems of value. This is obviously a major omission for a philosophy which is directed to the future and is calling for active change of the world in a defined direction. Marxism clearly puts forth a set of values aimed at satisfying human needs. Subsequently, in claiming that man is „a natural being" or „a part of nature," the concepts of „natural" and „supernatural" (divine and demoniac) necessarily become opposed. The existence of God is implicitly negated by Marxists; that is, the idea that man originated from a special act of the Creator who made him after his own image, that man is completely different from natural beings and is endowed with a unique capacity („spirituality") which allows him to be the master of the Earth and everything living on it.

There is also a more complex implication in the idea that man is „a natural being," that is, that he is in constant interaction with his environment in the general course of working and living. He is influenced by the world around him and also influences this world as a material force among other such forces. However, these formulations still do not express the full implication of the idea of Man as a natural being. The basic question still remains unelucidated: What is nature? Thus far, we have only defined nature indirectly, staring that it is everything except society and culture.

The distinction between natural and non-natural (social, cultural) is convenient since it justifies the use of the term „unnatural [11] (artificial) relating to man-made objects (industrial, artistic, etc.). These are unnatural in the sense that man has made them serve his own purpose. From the vantage point of the human time scale, nature is relatively constant and generally more slowly changing in comparison to social dynamics which arc often seemingly arbitrary or stochastic and characterized by rapid flux.

A major problem in relation to „man and his environment" is to find the optimal interaction which will ensure harmony of man's somatic, psychologic and social being. Many „revolutionary" philosophies of the 19th and 20th centuries which exhorted people to destroy established values for the sake of future

„progress" not only failed in achieving their aims, but actually took civilization a step backwards. This had long-term negative consequences of suppressing the creative, psychological potential of the broad population for several generations. The discrepancy between word and deed, aims and reality, truth and hypocrisy were the unfortunate accompaniments of many „revolutionary" movements. The disillusionment the failure of these ideals brought can be considered as **a** new form of pollution—let us say a „mental" one—whose consequences for civilization are as important, if not in some cases greater, than those of a physical-chemical nature.

This ideological pollution induces the most conflicting moral crisis in individuals and the human community in general. Even if an equal level of self-deprivation could be attained for all members of the human community (which has seldom been the case), the question of purpose still remains. What would be the human purpose of sacrificing entire generations, (even in cases when the initial political and economic conditions arc provided for a somewhat higher level of satisfying individual needs)? Naturally, an clement of conscious and voluntary self-sacrifice is present in each true „revolutionary" activity: this activity is always conducted on a collective level with collective aims. In order to participate and in that way experience human fulfillment, the individual exposes himself to risk and deprives himself of some of his personal aspirations**.** In this way, he overcomes his alienation and attaches himself to a social ideal which provides him with a profound purpose to his existence. However, in post-technological society, total sacrifice of an entire generation for the ideal of a better life for future generations is not morally justified even if the ultimate outcome is completely favorable.

3. Some Neurobiological Features of Values

The problem of value is an essential philosophical category and an unavoidable factor in studying ethics, aesthetics, economics, religion and the theory of knowledge. Therefore, treating this issue in the context of neurobiology may be condemned to failure. Although from traditional experience I am aware of this risk, I shall try to formulate certain attitudes and accentuate some additional factors which could, in my opinion, be related to the biological basis of values. I am quite sure that the majority of scientists dealing with this issue on the conventional basis would reject any possibility of relating this concept to biology, especially when the post-Kantian (Hartman, [6] Moore [12]) premises are taken into account. The so-called emotionalists (Stevenson [10]) are some-

what closer to biological attitudes. Biology is interested in investigating ethical behavior in the context of Darwin's theory of evolution. The idea of phylogenetic heritage faces us with the problem of the origins of „moral" behavior. These are elaborately investigated by Thomas and Julian Huxley [7] as well as by numerous ethologists and anthropologists (Lorens,*. Montagu [11]), There has been particularly sharp controversy concerning the relationship between aggressive and altruistic behavior. Without further elaboration of the principles of Darwin's evolution, I would like to accentuate the concept of *adaptation* which has significantly influenced the strategy and mode of thinking in all scientific disciplines dealing with animal behavior. In my opinion, investigation of adaptive behavior could be the basis for a neurobiological interpretation of values relating to homeostatic regulation and regulatory systems of behavior and learning.[6]

Following the discoveries by Moruzzi and Magoun[1'] on the diffuse reticular activating system essential for maintaining vigilance, several years ago we formulated a concept of the subcortical inhibitory system located in the structures immediately below the cerebral cortex (Neostriatum)."[6] Complementary action of the two systems regulates not only the basic neural processes, excitation and inhibition, but far more complex integrative cerebral functions as well. Understanding these regulatory systems makes possible better insight into higher cortical functions. Information from the external environment reaches the cerebral cortex via specific sensory pathways. There are connections between the reticular formation and other regulatory structures (limbic, thalamic, etc.), while the influences from these structures reach the cerebral cortex by other mechanisms. The inputs from specific sensory pathways directly reflect environmental characteristics, while those from the reticular formation are most probably related to processing of sensory information. Consequently, perception results not only from cortical mechanisms, but from their permanent interactions with subcortical regulatory systems. Thus, the physiologic concept of value must be related to the interaction of specific information with the nonspecific influences of the regulatory systems in the brain itself (both activating and inhibitory). The regulatory systems not only prepare the cerebral cortex for processing information, but also inform the cortex about the internal environmental condition. Besides a general tonic regulatory effect, this information from the internal environment is integrated with the specific information from the external environment, which reaches the cortex at a given moment. Therefore, 1) analysis of the environment surrounding the organism is nor feasible without information about its

own functional status, and this determines how the organism will evaluate and act upon the external events, and 2) this plays a decisive role in determining behavior.

Numerous experiments in our, as well as in other, laboratories have confirmed this hypothesis and revealed numerous possibilities for modifying spontaneous and conditional behavior either by electrical or chemical stimulation. The functional state of homeostatic regulation profoundly affects avoidance behavior and selection of priorities, and thus determines whether an object in the external environment will be sought or avoided. The estimation of priority or avoidance is a prerequisite for finding a solution. Here we arc coming closer to the problem of values.

Regulation provides stability by resisting deviations from a standard value by maintenance of a constant chemical environment in the organism. Deviation from this fixed range endangers functioning or even the life of the organism. Therefore, any agent which promotes deviations is deleterious and any that helps reestablish homeostasis is beneficial. (Thus, at the level of vital functions values are very closely related to self-interest). Is it then possible to explain the biological basis of moral behavior by principles of homeostasis? When molecular and lower (reflex) neural mechanisms fail, elementary homeostasis can be reestablished with the assistance of „higher" motivational mechanisms. Motivation, if the original definition is used, forces the organism to change its position in its environment. In this way the organism can satisfy its needs and acquire knowledge needed for coping with similar situations in the future. Thus, motivation is one of the most significant mechanisms of adaptive behavior. In order to avoid simplifications, I emphasize that „higher" psychic functions are a reflection of the defined organization of informative processes in the brain, indicating a high level of coordination between all the links in the chain which form the system of the given psychic function. Complex cerebral integration is provided by the structural characteristics of the brain, the presence of highly differentiated neuronal assemblies, cortical fields and links, and specific biochemical organization. This complicated basis provides the neural substrate for formation of the psyche. Of course, in order for the development of the personality to occur individual experience is indispensable. This experience is vital to the formation of consciousness—comprehension of one's own personality, including the concept of value. Individual experience is formed in the course of ontogenesis in which a being (a man) initiates a relationship with other beings (men) based on social experience.' Consciousness and experience

are formed in the process of communication and are maintained throughout life. By interacting with other people, man learns about himself. Social experience is reined to the highest achievements of human culture, and science to the most complex expression of human psychic activity.

The enormous achievements of modern science, as well as the scope of our knowledge, encourage a number of practical conclusions but also require an increasingly critical attitude in considering the issues. Consequently, the scientific edifice of neurobiology forms a pyramid, the basis of which is knowledge and achievements acquired over centuries, and its peak being creative concepts and hypotheses, frequently bold and sometimes apparently paradoxical. Dogmatism is a severe obstacle to development in the neurosciences.

4. Methodological Problems of Hierarchical Organization of the Brain

The levels of brain organization, as complex hierarchical systems, form the most important methodological issues of neuroscience.'[5] These significantly influence the outcome of any brain research. They arc particularly interesting for elucidating the relationship between the brain and human consciousness and can, therefore, reflect the hierarchy of matter and function, matter and time, and „cause" in hierarchical system.

a) Hierarchy of matter and function

For all levels of material organization a specific dynamic exists. From the ontological point of view; three types of errors occur in describing the relationship between the level of organization and the corresponding type of function. The „reductionistic" error is seen when a function typical of a more complex level of organization of matter is described by laws characterizing its lower, less complex levels. The „transductionistic" error occurs when complex laws are attributed to a simpler level of function. „Integrative" errors consist of using a common type of function (when it does not exist in reality) to describe several levels of organization of matter.

All three types of errors lead to scientifically incorrect results and, from the ontological point of view, reflect objective reality inaccurately. However, from the gnoseological point of view, all of the above approaches may play a positive role at certain stages in the acquisition of knowledge. The reductionistic and transreductionistic approaches are a basis for modeling, and while

as such are useful, obviously cannot fully describe the dynamics of higher systems. Accentuating the similarity between the natural and social sciences and developing a system of common concepts and terms can also be useful.

Subcelluiar macromolecular functional units (ionic membrane channels, individual neurons, neuron modules and neuronal networks representing the material basis of individual human consciousness) arc examples of different levels in a single system.

b) Hierarchy of matter and time

Different types of matter are characterized by „their own dynamics" as a „form of their existence." Interactions would not be possible at all without temporal coordination of processes proceeding at different levels. Thus, the temporal aspects of phenomena at various levels do not remain independent. Certain types of „time. sharing" occur among them. Metaphorically, it could be said that in similar systems a common time axis for processes taking place at several levels of matter organization is being formed. In complex hierarchically organized systems characterized by interactions among levels and between the system and its environment the unification of time takes' place with greater probability. In a nervous system individual functional levels are characterized by „their own dynamics" and in the course of the interaction of these levels communication-unification of time probably takes place. Apart from that, the nervous system is characterized by special mechanisms which reflect external „physical" time. This is a prerequisite for interaction with the external environment. Even simple organisms arc **capable** of not only recognizing external **„physical"** time, but also of predicting physical processes, particularly cyclic processes (day and night, tide and ebb, etc.) which will take place in the future. These simple organisms can then adjust their metabolism and external behavior to these events. At the same time, the biological „clock" which is essential for these adjustments is protected against errors. Thus, even poikilotherms can protect themselves against random day to day variability in the external temperature which may be superimposed upon the („tonic") seasonal climatic changes anticipated by the organism's „biological clock."

c) „Cause" in hierarchical systems

There arc two concepts of „cause" and „effect" in such complex hierarchical systems as the human central nervous system. On the human perception level, the image of a given visual stimulus in the external world formed at the

retina can be considered „cause." At the physiological level, transformation of light energy into nerve impulses in receptor cells in the retina and information processing in nerve cells at various stager along the visual pathway „cause [1*] an external object to be represented in the cerebral cortex, or more specifically, in the corresponding neuronal networks.

The causal chain of consecutive processes within each level of organization of the brain is evident (from molecular to subcelular, cellular, multicellular and the whole brain). The initial processes are the „cause" of subsequent ones which arc their „precondition. [11] However, relations among different levels are more complex (Rose).[17] The transformation of a given distribution of light energy into a specific spatio-temporal pattern of nerve impulses in the millions of receptive cells distributed over the retina „causes" the formation of an image on the retina. However, the relationship between „cause" and „effect" is completely different from that in the previous case. The processes at both levels occur simultaneously. The „basis" of the formation of the image on the retina is nothing other than the generation of nerve impulses in the complex and extensive network of retinal receptor and nerve cells.

The statement that the relationship between different levels can l>e described by a simple „translation" is incomplete. If that were true, the above example of impulse activity of receptor elements would merely translate into „another language." However, this assumption is an over simplification. The relationship between both levels is complex. There is not a simple one-to-one correspondence of a given process at various levels. The dynamic principle of „parts" (representing the lower level) and „whole" (representing the higher level) is of key importance for understanding the above relationship. If it were possible to separate the image on the retina into parts, only a large number of receptors and nerve cells generating nerve impulses at a given instant would be detected. However, since the „whole" has its own integrated structure and function, it is characterized by a qualitatively higher level of organization, it is not merely the sum of its parts.

5. „New Alliance" and Neuroscience

Several years ago Prigogine [14] put forward the concept of a „New Alliance" between man and nature which, despite of its mystical elements, is worthy of review in the context of the neuroscience as it may open new possibilities for understanding the problems of regulator)' systems and values.

Four concepts are selected here for analysis: The complexity of the parts and the whole, the unidirectional nature of processes, variability, and the relationship between induction and deduction.

a) Complexity of the parts and the whole

New scientific data reveal that elementary nervous processes arc no simpler than those on a higher, more general level of organization of the nervous system. It was once popular to consider the human brain a complex system of simple components whose elegance was ‘due primarily to the way in which these simple components were interconnected. The idea that nerve cells are binary functional elements forming an information-processing. system similar to electronic computers has, in general, played a positive role in the development of scientific thinking, and has contributed to the origin and development of cybernetics with its theoretical as well as practical results. According to Radii’s cybernetic principle, a system comprised of relatively simple and failure-prone components was formed in the course of development. This system is considerably more complicated, more ideal, and *relatively less* failure-prone than its components. This formulation clearly applies to the human brain. In recent years important new data have been obtained. Analytical neurophysiology has been developed at the macromolecular level. The structure and function of macromolecules in neuron membranes have been described. These include ion channels, which allow selective penetration of specific ions into or out of the cell, and membrane receptors—with a selective sensitivity to specific substances in the intercellular space. It has also been ascertained that information processing takes place not only among neurons, but also in the dendrites of the individual neurons. Of great importance is the discovery that communication in neuron nets is affected not only by synaptic transmission but also humorally. Nerve cells arc characterized by neurosecretory activity, by the synthesis and release of peptides and polypeptides which transfer information from one cell to another. The target cells arc not always part of the nervous system. Progress has been made particularly in the study of endogenous opioids (endorphins) which arc important in pain, emotion and probably also motivation.

b) Unidirectionality of processes

Unidirectionality of processes in time is indisputable with respect to the nervous system. The neurons responsible for nervous processes, including the most complex ones which form the basis of psychic processes, arc „incapa-

ble" of further division, and have reached the final phase (differentiation). Dedifferentiation is always a sign of serious pathology. In the course of postnatal life, we arc probably only losing nerve cells. This is of great significance from the viewpoint of the functional organization of the brain. Thus, important activities can be undertaken even after the loss of a large number of neurons. There is also a relatively large reserve capacity of the brain whereby intact structures can often take over the lost function when there is damage to a given part due to trauma, hemorrhage, etc. Despite these compensatory mechanisms, the loss of nerve cells overall has unfavorable functional consequences.

In the formation of the relatively stable multicellular formations in the central nervous system in the course of ontogenesis there is. in element of chance. The development of the brain in an individual proceeds only partially according to the genetic plan provided in the course of phylogenesis. The realization of this plan is also conditioned by external factors. During certain phases of ontogenesis, factors outside the CNS play a particularly important role. Both humoral factors (sexual dimorphism in some activities of the brain) and exogenous factors mediated by the senses (bonding between mother and child, and determination of sexual behavior after maturity in various animal species) are involved. Since the environment is inconstant, external factors cm never act completely identically. The incomplete genetic determination of „behavior" also allows complex adaptation to the ever-changing environment, including the social milieu (from the simplest forms of conditional reflexes in primitive animals to the highly complex volitional behavior of man).

c) Variability

Invariable nervous systems, an invariable brain, and „invariable" man are only abstractions. Nervous processes continuously reflect the changes taking place in the external environment and in the organism, including the nervous system itself. These processes represent active adaptation, including purposeful interventions upon the environment and regulation of internal processes.

According to Prigogine, it is incorrect to consider the brain and sense as invariable. This has been done in some fields of psychophysics, where nervous activity is reduced to a series of physical concepts.

The problem of variability over time in human psychophysiological research is indeed a thorny one. Measures which must be repeated several times over hours, days, weeks or even months inevitably arc affected by factors other than

those under study. Thoughtful experimental design and proper application of statistical techniques are obviously essential, but are not always a guarantee that the obtained results accurately reflect psychophysiologic reality. The researcher himself and the general scientific audience must be constantly aware of this problem and interpret findings critically.

d) Inductive-deductive relationships

Inductive study of the structure and the function of nervous systems has remained the basic method of acquisition of new data and knowledge, while the application of deductive methods is of far more limited significance.

The purpose of research in the field of neuroscience is not merely to obtain individual facts, but rather to understand the actual functional and structural principles winch arc „behind them" and which condition them. This is possible only by the observation of nature and the execution of experiments, and then by the Logical and ontological interpretation of the results. Deduction on the basis of discovered principles and topical hypothesis (including model testings) and theories arc of supplementary significance only. Their validity must always be verified experimentally. It is clear, however, that modelling can eliminate low probability variants which are not worth experimental verification as well as select likely variants for which verification is of interest. For this reason, under certain conditions, a model may be useful from the gnoseological point of view. However, in no case should the application of mathematics for modelling result in the impoverishment of our cognition of the world with all of its important details, vast diversity end dynamic variability

The attempt to explain the extraordinarily diverse findings of contemporary neuroscience by deduction, using a limited number of very general laws, is dearly ineffective and utterly sterile. Such an approach inevitably results in unjustified simplifications—to reductionism**.** Furthermore, this approach reduces motivation to research: Why design complex experiments if the knowledge can be achieved by deduction? In neuroscience this method is realistically possible only in exceptional cases.

The present inductive method, which characterizes the majority of contemporary research, will most probably prevail in the future. Detailed experimental work in psychophysiology, for example, is providing as with essential insights into the functioning of the human brain.

6. Transfer of Concepts from the Natural to the Social Sciences

The enormous advances in the natural sciences occurring during the modern era, particularly in this century, have had a profound influence ujxhi the development and direction of the social sciences. We cannot discuss here in detail the numerous examples of concepts from physics, chemistry, mathematics, biology, astronomy, etc. which have greatly affected the social sciences. In our era the most important examples include Darwin's theory of evolution, Einstein's theory of relativity Freud's theory of instinct, Pavlov's concept of conditioning, cybernetics, systems analysis, etc. The attitude of the social scientists to the concepts and methods of the natural sciences has ranged from blind acceptance to complete rejection. Clearly, this has been an area of great controversy.

A number of scholars since the late nineteenth century, predominantly philosophers of history, have opposed the idea of including social theory in the sciences. Most of these thinkers have been convinced that the scientific method of inquiry developed. since Galileo—predominantly by physicists—is much too simple, static, quantitative and deterministic to do justice to human social reality. Such a view was first stated and systematically developed by the father of the „philosophy of life" *(Lebensphilosophie),* the German philosopher Diltsey, and by the Baden neo-Kantian school (Windelband and Rickert).[10] In both cases, the idea of a unified scientific methodology was opposed on the grounds that there is an obvious gap between „uniform, blind, and repetitive" natural phenomena on the one hand, and the unique acts of conscious agents in history on the other—that it is necessary to use completely different methods and to separate these fields of study- The former (natural phenomena) can be explained and belong to *ideographic* sciences. The latter (human historical phenomena) can only be *understood* and belong to *ideographic* sciences.

Very different groups of thinkers, and for different reasons, have advocated a sharp separation of humanistic studies from natural science. Existentialist authors (Sartre [18]) subscribe to that view because it follows from their basic principle: human existence is unique, free and precedes human essence; therefore, it cannot be explained in terms of any past regularity of behavior or in terms of any more or less general scientific theory.

Surprisingly enough, there was also a powerful trend in twentieth century Marxist thought which—partly under the influence of the German „philosophy of life," and also partly in opposition to strong positivist tendencies in

Western philosophy and to Soviet dialectical materialism—strongly resisted any application of contemporary general scientific methodology to social sciences. Representatives of that neo-Marxist trend include Lukacs [10] in his early book *History and Class Consciousness,* some members of the Frankfurt School (Marcuse, Horkheimer and Adorno with their critical social theory and negative dialectic), and some leftist Yugoslav philosophers who hold that social science is only able to offer a fragmented and distorted picture of man and, therefore, is entirely irrelevant for humanist philosophy [10]

During the past decade, thanks to the efforts of the International Conference on the Unity of the Sciences and others, there have been major efforts and achievements in creating the concept of a unified science, which includes the natural and social sciences and applies the concepts and instruments of these sciences to solving problems. This has contributed to increased objectiveness in the social sciences: first, by providing concepts and techniques to distinguish between the apparent-illusory and the actually existing; and second, by helping to remove cultural bias. Planets and electrons have no nation and belong to no religion, race or class. By attempting to discover the truth about them, man began to learn how to behave as a *universal* being. In addition to classical humanist philosophy, modern natural science has been another source of the universalist spirit in our civilization.

It should be noted that the decisive battle for modern rationality was won by eighteenth century physical science. Once man learned to discover hidden inner regularity beyond the apparent chaos of individual events, he became capable of predicting and controlling natural processes and no longer needed mythical entities and irrational prejudices to satisfy his curiosity and preserve his sanity.

The advanced and refined methodology of the natural sciences also helped the social sciences to accelerate their concrete, specialized knowledge. Accentuating the importance of the biosciences for human behavior does not imply a forceful incorporation of the social sciences into biology. It is rather an effort to help psychologists and sociologists become aware of the importance of biological factors as well as to help, human biologists account for sociopsychological variables. As Semur Kety 8 pointed out in his classic work A Biologist Examines the Mind and Behavior; „Many disciplines contribute to understanding human behavior, each with peculiar virtues and limitations.'1

Reductionism has had a powerful influence upon numerous scientific disciplines, especially biology. 1' Its philosophical premises are:

a) sciences are arranged in a hierarchical order, from economics and sociology to biology, chemistry and finally physics; and

b) phenomena in the former disciplines Gin be reduced and explained by laws of the latter.

Ultimately, therefore, physical laws can subsume and explain sociology, economics, etc. Without rejecting the great practical importance of reductionism, I shall here stress the danger of mechanically applying physical laws and positivistic transformation (molecular, evolutionary and behavior reductionism) to explain complex biological and social phenomena.

In this regard the problem arises in neurobiology of extrapolating the results of animal experiments to arrive at conclusions concerning the functioning of the human brain.

The basic structural and functional elements do not apparently differ qualitatively in humans and higher mammals, particularly subhuman primates. 23 However, this does not hold for the most complex human neural processes. Their specificity and elegance arc determined mainly by: 1) the complexity of the interrelations of the elements, and 2) the influence of the highly developed social environment. Individual human consciousness is defined according to the point of view of a given discipline. Behind these various definitions which are influenced by conceptual frameworks—different gnosceological approaches—there is an ontological unity of the human brain and its functions. A convergence of approaches and the gradual advancement of a unified general theory concerning the function of the human brain, can be expected in the future. The development of eon-temporary psychophysiology—analyzing mental phenomena by means of objective methods—represents an important step in this direction.

On the other hand, it would be unrealistic to absolutize the differences between specifically human neural processes and psychic phenomena and those of higher animals. Whatever is really important in humans exists in a germinal form in subhuman species, especially in the highest and most social ones. A rational degree of „biologization" docs not make man less human; it is reflected more in the arts than in science. There arc several phylogenetic routes

which arc indubitable. These arc: love and sexual relationships between man and woman and the conception of offspring; birth and development; the relationship between generations; individual efforts to adapt, to seek and discover, to struggle against an unfavorable environment and to survive; disease and death; the finiteness of individual life and the relative stability of the broader social entity (group, nation, species, etc.); social hierarchy (the fight for social position and power, the relationship of those who rule and those who obey, stability and dynamics within the social groups); human solidarity (altruism and cooperation, the collective effort to survive as a group, and to maintain some form of peaceful coexistence).

The prospect for solutions to these questions within the neurobiological disciplines and integrated neurosciences is promising, even though it may appear impossible given the current level of knowledge. During this century, discoveries have been made which have enabled us to gain a more exact insight into the function of the human brain and to elucidate numerous mechanisms of disease. I believe that only the integration of knowledge within a broad spectrum of scientific disciplines will provide the means for understanding the most complex living being—man.

The importance of neurobiology in creating a general philosophy of values has been emphasized, particularly in several ICUS meetings, by many leading investigators in this field (Eccles, Delgado, Granit, Popper, Sperry and others) who have helped formulate theoretical approaches on the basis of their experimental results. In general, we can see that most of these existing ideological formulations are inadequate in helping man to cope with enormous amounts of new scientific and technological knowledge, and allowing him to rationally and humanely plan and control his future. By discovering biological mechanisms which may describe the overall potential of the brain and be expressed under the influence of exogenous factors, neurobiology has opened up many new problems extending well beyond its own domain.

We cannot overlook the fears related to possible social consequences of brain research, although it is difficult to predict exactly when we shall be able to change certain brain functions clearly and radically, using chemical agents, since the majority of substances modifying brain functions have general and multiple effects rather than specific ones. Numerous pharmacological agents with a wide spectrum of psychological effects arc already available. Therefore, there is a need not only for investigation of their modes of action, but also

for insight into their specific indications, correct application and potential for abuse.

Adaptation of" the human being to the constantly changing conditions of the environment represents one of the major problems of our era. Different professionals in the social and life sciences (psychologists, economists, sociologists and physicians) carry responsibility for protecting and guiding the individual, the community; – and society as a whole to adapt to and alter their environments to meet their human needs. There is also a need for better detection, treatment and investigation of new disorders which are specific responses of the organism to the noxious agents of our era (maladaptation disorders, generic, psychosomatic, malignant diseases, etc.). Broad cooperation on national and international levels arc essential here. Unfortunately, optimal conditions for this cooperation do not exist: we have based our modern societies on competitive rivalry rather than cooperative association. Competition in industrial, commercial and national endeavors may have stimulated material progress in certain, limited cases, but at the same time it has accentuated the worst elements in human nature. As a basic principle for society, competition—considering only the egotistic wishes of an individual and ignoring the needs of other people—is not acceptable because it is unethical and in the long run self-defeating. Cooperation emphasizes those human qualities that arc in accordance with moral law. It is as wise as it is virtuous.

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