

CONSCIOUSNESS AND THE BRAIN

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From June 3-6, 1992, an International Symposium, "Consciousness and the Brain", dedicated to the memory of M. N. Livanov, was held at the Institute of Higher Nervous Activity and Neurophysiology of the Russian Academy of Sciences (Moscow). M. N. Livanov's principal contribution to the science of the brain was the idea of the linking of neural structures on the basis of the co-tuning of their rhythms, which finds its expression in the synchronization of electrical potentials. M. N. Livanov was one of the pioneers in the computer analysis of the electrical activity of the brain. The electroencephaloscope which he developed was the precursor of contemporary brain maps. It was favorably distinguished by the fact that it offered the possibility not only of seeing the distribution of potentials on the surface of the cortex, but to identify the connections between its divisions as well.

The latest results of an investigation of the physiological basis of higher mental functions and human consciousness were presented at the symposium. Many of the reports presented contained a development of Livanov's ideas. Below are published articles written on the basis of the materials of reports at the symposium.

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Following the advice of I. P. Pavlov to the effect that "it is important to understand psychologically before translating a phenomenon into physiological language", the author defines more precisely the content and origin of consciousness as a phenomenon of human higher nervous activity. The necessity of distinguishing two fundamentally different phenomena in the sphere of unconscious mental activity, defined as subconsciousness and superconsciousness, is substantiated. The emotional languages of superconsciousness are described, namely, the senses of beauty, humor, and conscience. The contradictory nature of objectively determined behavior along with subjectively experienced freedom of choice are regarded from the points of view of their initial complementarity. It is asserted that the activity of superconsciousness, recombining previously accumulated experience, underlies the so-called self-determination of behavior, as a result of which decision options may arise that have never been encountered previously. In other words: the freedom that is maximally available to man is manifested in his creative activity.

The unbroken link between the study of brain activity and materialistically oriented psychology represents a characteristic tradition of our national science, which is associated with the names of I. M. Sechenov, I. P. Pavlov, A. A. Ukhtomskii, V. M. Bekhterev, and L. S. Vygotskii, their students and followers. The fruitfulness of the union of psychology and brain physiology was brilliantly formulated by L. S. Vygotskii. "The insoluble character of the problem of the mind for the psychology of the past," wrote Vygotskii, "in fact lay to a significant degree in the fact that due to the

idealistic approach to it, the mental was torn out of that integral process of which it constitutes a part, and the role of an independent process was ascribed to it, a process which existed along side of and apart from physiological processes... We should study," Vygotskii urged, "not separate mental and physiological processes ripped from a unity, which in the process become completely incomprehensible to us; we should take hold of the whole process which is characterized from the subjective and objective aspects simultaneously" [2, p. 37].

I will demonstrate the effectiveness of just this approach on the basis of two examples of the research practice of recent years.

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A. M. Ivanitskii has compared the physiological manifestations of the processing of an external stimulus in the form of evoked electrical potentials of the brain (EP) with the subjective psychophysiological indices of perception that can be described within the framework of signal identification theory. As a result of these investigations, three stages in the formation of the subjective image were distinguished and their mechanisms examined. At the first stage analysis of the physical characteristics of light, acoustic, etc., signals are analyzed, the objective manifestation of which is the early components of the EP with a latent period up to 100 msec. The processes constituting the content of the first stage of perception represent, as it were, the preparatory phase of perception: they are not yet accompanied at the mental level by any phenomena.

Mental sensation arises at the second stage, when comparison of the physical parameters of the stimulus with information retained in memory takes place, thanks to which its significance, its relationship to the needs of the individual, is determined. This moment coincides with EP waves which appear between 100–200 msec following the beginning of the action of the stimulus. At the third, concluding stage of perception, the definitive recognition of the stimulus, its identification, takes place; this is reflected in the evoked potential wave designated as P_{300} , and is most distinctly observable in the anterior, frontal divisions of the brain. If, depending upon the character of the stimulus, the subject should choose one of the possible response options, yet another complex is recorded in the EP pattern, one which has been called the "choice reaction potential", and is probably associated with the processes of decision regarding the respondent action [7]. The striking coincidence in time of all of the stages of subjectively experienced perception with objectively recordable events playing out in brain tissue makes it possible to speak of them precisely as different manifestations of a unitary integral process.

I borrow the second example from my own experience. In 1964 the results of experiments led us to the inference that emotion is the reflection by the brain of man and the higher animals of some immediate need and the probability (possibility) of its satisfaction at a given moment. The relationship of the strength and sign of the emotional reaction to the magnitude of the need and the probability of its satisfaction was then repeatedly demonstrated in psychophysiological investigations in which the strength of emotion was judged on the basis of the magnitude of objectively recordable shifts in physiological functions (heart rate, fluctuations in cutaneous electrical potentials, changes in the electrical activity of the brain, etc.); need was judged on the basis of the intensity of an avoidable unpleasant stimulation or on the basis of the duration of starvation; and the possibility of satisfaction was judged on the basis of the total amount of errors allowed by the subject or on the probability of the reinforcement of conditional signals [14]. In 1984, the American investigators D. Price and J. Barrell reproduced these experiments in a purely psychological variant, proposing to subjects that they mark on special scales the strength of their desire, the presumed probability of achieving a goal, and the intensity of the emotional experience. The quantitative analysis of the data obtained confirmed the existence of the relationship which the authors called a "general law of human emotions" [21].

The need-informational theory of emotions has lain at the base of numerous experiments involving injury and the recording of the electrical activity of various divisions of the brain, among which it has been possible to distinguish two systems. One of these (the anterior divisions of new cortex and hippocampus have been assigned to it) assesses the probability of need satisfaction, whereas the other, which includes the hypothalamus and the nuclei of the amygdaloid complex, distinguishes the dominant need which is subject to priority satisfaction. The emotional state experienced by man at a given moment is in fact the result of the complex interaction of these four brain structures [15].

If physiological experiments have made it possible to formulate a conception which has received confirmation from experimental psychology, then support from psychologists has prompted a return to neurophysiology and to an attempt to "superimpose" this new theory of emotions on the analysis of the interaction of anatomically arranged and functionally specialized structures of the real brain. How could we not recall here a recommendation of the outstanding Soviet neuropsychologist, A. R. Luriya: "Before answering the question as to the bases of one or another mental process, it is necessary to study carefully the structure of that psychological process, the cerebral organization of which we wish to establish, and to distinguish in it those elements which to one degree or another can be related to specific brain systems" [10, p. 76]. I. P. Pavlov had also spoken of this: "It is above all important to understand psychologically, and then to translate into physiological language" [13, p. 275].

However, such a point of view is hardly shared by all. Here is what V. P. Zinchenko just recently declared in his interview with the journal "Chelovek": "I will cite an entire series of postulates current even today in the scientific and educational literature on philosophy, psychology, pedagogics, and physiology: man is the possessor of higher nervous activity who is devoid of organs of mental and spiritual life... Consciousness has been sought and is sought in the brain, despite the warning of the great physiologists and neurophysiologists (from C. Sherrington to A. R. Luriya) regarding the uselessness of such searches... In summary, consciousness has been encapsulated in the individual and has lost its social meanings and significances" [6, p. 12]. The polemic with Zinchenko is made difficult by the fact that he does not define the concrete content which he himself has embedded in the term "consciousness". Does consciousness include the entire internal, spiritual world of man? How is consciousness distinguished from such mental phenomena as intellect, thinking, cognition, etc.? How does consciousness interrelate with motives, emotions, and the will? Without an answer to these questions the discussion on the theme "consciousness and the brain" becomes minimally productive.

From our point of view, consciousness is knowledge which by means of words, mathematical symbols, and the generalizing images of artistic works can be transmitted, and can become the property of other members of society, including of other generations in the form of cultural monuments. The communicative origin of consciousness governs the capacity of ideational dialogue with oneself, i.e., leads to the appearance of self-consciousness. The internal "I", which judges one's own acts, is nothing other than an interiorized "other". It is appropriate to recall that S. Freud ad-

heres to a similar point of view. "The real difference between unconscious and preconscious representations," believed Freud, "resides in the fact that the former is achieved by means of material which remains unknown (uncognized), whereas the latter is associated with the *representations of words*" [17, p. 429, emphasis added by Freud. — P. S.].

The investigations of neurophysiologists carried out at the N. N. Burdenko Institute of Neurosurgery under the direction of O. M. Grindel', attest to the decisive role of the functioning of speech structures of the brain in the phenomenon of consciousness. They demonstrated that the recovery of consciousness in patients with severe craniocerebral trauma coincides in time with the restoration of the connections between the motor speech zones of the left hemisphere (in right-handers) and other areas of the cortex [4]. É. A. Kostandov, on the basis of his systematic experiments in the Institute of General and Forensic Psychiatry of the Russian Academy of Medical Sciences came to the conclusion that "the activation of the connections of the gnostic cortical areas with the motor speech zone is a decisive element in the structural-functional organization of mechanisms supporting conscious awareness of a stimulus" [9, p. 408].

The discovery of the functional asymmetry of the brain has exerted a genuinely revolutionary influence on the study of natural science foundations of consciousness. At the same time, it would be an unjustified oversimplification to confine consciousness and speech exclusively to the left hemisphere, since the initial stages of the generation of an utterance in the native tongue are associated with the right hemisphere, while the final formulation is associated with the left. However paradoxical this may seem at first glance, patients with a lesion of the left hemisphere are anxious, worried about their state and their future. In the case of a right-sided lesion of the brain, patients, on the contrary, think in a facile and carefree manner [1]. In the most general form it can be stated that the right hemisphere is more associated with the motivational sphere of the personality, while the left is more associated with the cognitive (informational) sphere. Data on the primary connection of the right hemisphere with the diencephalic division of the brain, and of the left with the activating brain stem formations [1], argue in favor of such an hypothesis. Figuratively speaking, an individual with a lesion of the left hemisphere is a subject with a rich set of needs and a shortage of means to satisfy them. A patient with a lesion of the right hemisphere has at his disposal an excess of means for the satisfaction of a markedly impoverished, narrowed, simplified sphere of motives. Hence the inclination to the predominance of negative or positive emotions arises secondarily. In the case of a lesion of the left hemisphere, speech is disturbed, but the personality is preserved. In a lesion of the right, self-consciousness and self-evaluation suffer.

Observations on patients with brain pathology again confirm the notions regarding the personality as an individually unique composition and an internal hierarchy of the vital, social, and ideal needs of a given individual, including the varieties of their maintenance and development, "for oneself" and "for others". The ruling need i.e., dominating more often than others and for a more prolonged period than others, the super-task of life, in the expression of K. S. Stanislavskii, is the true nucleus of the personality, its most

essential feature. We should note that we most often encounter a quite complex combination of needs, that are far from always consciously recognized by the subject himself. But, in any case, human personality will be characterized by its motivational dominant. Thus, there is a huge difference between fear and cowardice. Fear is a natural emotional reaction inherent in each of us and generated by the need for preservation, and not necessarily of oneself; there can also be fear for the other, for a construction which is a result of collective efforts, etc. By contrast with fear, cowardice is a feature of the personality, because cowardice as "the worst of human vices" (M. Bulgakov) implies that the need for self-preservation, having become the motivational dominant, overmasters needs which coexist and compete with it, needs to conform to specific ethical norms, overmasters the sense of duty and responsibility for the fate of other people.

Evidently definite connections exist between the needs, consciousness, and the unconscious manifestations of the higher nervous activity of man.

The communicative origin itself of consciousness renders it unavoidably social. The interiorized "other" (more precisely: "others"), subjectively perceived as my interior "I", generates not only the capacity of ideational dialogue with oneself, but the fundamental possibility of the lie as well, i.e., the possibility of thinking one thing and saying another. As the psychoanalyst Françoise Dolto wittily noted, "It is impossible to lie to the subconscious. It always knows the truth" [5]. Let us recall that all that which was conscious or can become conscious under certain conditions belongs to the subconscious, namely: habits which are well automatized and therefore have ceased to be consciously perceived, motivational conflicts expelled from the sphere of consciousness, social norms deeply assimilated by the subject (Freud designated them by the term "Superego"), the regulatory function of which is experienced as the "call of the heart", the "command of duty" etc. There is also a direct channel of effect on the subconscious in the form of imitative behavior. Thus, the child through imitation unconsciously records standards of behavior found in his immediate surroundings, which with time become an internal regulator of his actions.

The subconscious gravitates toward the vital needs, towards instinctive behavior. This is manifested especially dramatically in extreme situations of threat to the individual and species (parental instinct) existence, when there is no time for rational analysis of the situation, but it is necessary to act on the basis of inborn and previously accumulated experience, instantaneously utilizing automatized habits. As regards superconsciousness (creative intuition), it probably belongs exclusively to the ideal needs of the cognition and transformation of the surrounding world. The transformation and recombination of traces (engrams) preserved in the subject's memory, the primary closure of new neural temporary connections, whose correspondence or noncorrespondence to reality is only clarified later, are the neurophysiological basis of the activity of superconsciousness. In essence it is the activity of superconsciousness in particular that is the mover of progress. Just as in an evolving biological population, the new arises through the selection of particular individuals, the evolution of culture transmits ideas and discoveries in a number of successive generations, social norms initially arise [sic] in the mind of

individual discoverers and creative individuals. Superconsciousness participates in the search for the means of satisfaction of vital and social needs only if elements of the ideal arise there. The conscious ideal becomes ever more social; the fate of ideologies may serve as a dramatic example of this.

If consciousness is armed with speech, the symbolism of mathematical formulas, and the figurative structure of artistic works, then the unconscious mental reports to consciousness on the results of its activity by the **experience** of feelings, i.e., by emotion. I have in mind the three principal "languages" of superconsciousness: the sense of beauty, the sense of humor, and the so-called "voice of conscience". In each of these three instances it is necessary to answer two questions: 1) what does the informational component of a given emotion consist in, be it an increase in the probability of achieving a goal in the case of a positive emotional reaction, or a decline in probability in the case of a negative emotional experience; 2) with the satisfaction of which needs are we dealing in the given case.

Beauty is always a surprise, a discovery, the joyful unexpected. The sense of beauty arises whenever that is which received exceeds the unconsciously predicted norm. Esthetic delectation is a positive emotion associated with the satisfaction of three needs: cognition, economy of forces, and the extensive equipment with that knowledge, those skills and abilities which lead by the shortest and most certain path to the achievement of the goal. It is not by accident that I. Kant defined the beautiful as the "play of cognitive capacities" [8, p. 219]. The capacity for the perception of beauty is necessary for any creativity. In the opinion of the physicist, W. Heisenberg, "the luster of the beautiful in precise natural science makes it possible to recognize the great interrelationship, even so far as its detailed understanding, before it can be rationally proven" [3, p. 275]. Man finds beauty in the phenomena of nature, perceiving them as **creations** of Nature, i.e., transferring to the phenomena of nature the criteria of his own creative capacities, his creative activity.

The incongruity between the expected and the obtained we also find in the sense of humor: it is not accidental that all anecdotes unfailingly consist of two parts. In the sense of humor we, as a rule, are dealing with intellectual superiority, with superiority in comprehension, in the assessment of events, persons, situations. Humor is associated with the satisfaction of the ideal need for cognition (comprehension) and a social need for self-assertion. Humor promotes the overcoming of outmoded norms, the rejection of trivial decisions. E. Fromm [18] regarded the incapacity to laugh as one of the features of the destructive, non-creative character.

Finally, conscience is the capacity for emotional reaction to the result of one's presumed or realized actions to the degree that they touch upon the satisfaction of two fundamental needs: the need for objective truth and altruistic benevolence. Conscience is the capacity for the self-assessment of one's own actions, not depending on norms accepted in the social milieu surrounding the subject. That is why conscience is fundamentally different from the sense of duty and the sense of guilt. There can be many norms and notions of duty generated by them, but it is impossible to imagine several "consciences". The voice of conscience is the voice of truth to the degree that it has proven accessible

to the given individual, the voice of sympathy to the degree that this is a capacity inherent to a given individual.

With regard to the soul and the spirituality, supposedly "incompatible" with the higher nervous activity of the brain [6], in contemporary word usage these concepts designate the individual manifestation in a given personality of an ideal need for cognition and of a social, altruistic need "for others". Primarily the first of these needs is taken to mean spirituality, and primarily the second is taken to mean altruism [16]. L. N. Tolstoi, in whose opinion the best of people lives primarily by his **own** ideas and **others'** feelings, while the worst live by **others'** ideas and by his **own** feelings, valued such a combination of truth and kindness in particular. Everything that distinguishes people derives from different combinations of these four bases, the **motives of activity** [11].

The fundamental "duality" of consciousness, the possibility of reflection, of viewing oneself from within, give rise to doubts about the integrality of psychology as a unitary science. Psychology is an interdisciplinary sphere of knowledge with irreconcilable points of reference, asserts H. Kendler of the University of California at Santa Barbara. The results of introspective observation are irreconcilable with the intersubjective analysis of behavior. Deductive explanation and behavioral monitoring correspond to the criteria of the natural sciences. Consistent interpretations and intuitive knowledge correspond to those of the humanitarian sciences. The acceptance of some criteria excludes the acceptance of others. The divorce of the two spheres of psychology is not only desirable, but inevitable [20]. M. Yella is more optimistically disposed: the subject of psychology is behavior, i.e., biologically or personally interpreted action, and its method experimentally verified knowledge; therefore the unity of psychology is achievable in principle [23]. P. Fraisse (R. Descartes University) is in sympathy with him. According to Fraisse, a paradigm exists which is unitary for all psychologists, since all psychologists investigate behavior, taking the situation and the personality of the subject into account [19].

The acknowledgement of the **supplementarity** of the objective and subjective analysis of behavior of man (N. Bohr advanced this idea in 1958) makes it possible to eliminate the contradiction that really exists between determinism and free will. Man is unfree (determined) from the point of view of the outside observer, who views behavior as the result of genetic rudiments and the conditions of upbringing. Along with this and the very same time, man is free in his acts from the point of view of reflecting consciousness. Subjectively felt freedom of choice and the sense of personal responsibility engendered by it engages the mechanisms of comprehensive and repeated analysis of the consequences of one act or another; this makes the ultimate choice more well-founded. The mobilization of such information from the reserves of memory leads to the intensification of the need which stably predominates in the hierarchy of motives of the given personality, as a result of which it acquires the capacity to withstand situational dominants, i.e., needs which are urgently actualized by the developing situation. When an act is chosen, the activity of superconsciousness may present as material for decision-making such recombinations of traces of previously accumulated experience which have never been encountered before in the life of the

given subject, nor in the experience of preceeding generations. In this and only in this sense can one speak of the singular "self-determination" of behavior as a particular case of the realization of the process of the self-propulsion and self-development of nature.

True freedom of will is achieved only in the creative activity of man [22]. Or in the words of the poet: "There two worlds in man — one which created us, the other which we create out of the age to the limit of our strengths" (N. Zabolotskii).

I would like to conclude this brief essay on the complex relationships between contemporary psychology and the science of brain activity with the words of I. P. Pavlov, who discussed this problem at the 12th Congress of Natural Scientists and Physicians in December 1909: "I do not deny psychology as the knowledge of the internal world of man. Nonetheless I am inclined to deny something of the deepest bents of the human spirit. Here and now I only defend and assert the absolute, indisputable rights of natural scientific thought everywhere and as long as, and where and while it can manifest its power. And who knows where this possibility will end!" [12, p. 125].

REFERENCES

1. N. N. Bragina and T. A. Dobrokhotova, "The problem of the functional asymmetry of the brain," *Vopr. Filosofii*, No. 2, 135-150 (1977).
2. L. S. Vygotskii, *Collected Works, Vol. 1* [in Russian], Pedagogika, Moscow (1982).
3. W. Heisenberg, "The significance of beauty in an exact science," in: *Steps Beyond the Horizon* [Russian translation], Progress, Moscow (1987), pp. 268-282.
4. O. M. Grindel', "Intercentral relationships in the cerebral cortex on the basis of the EEG coherence index during the recovery of consciousness and speech after a prolonged coma," *Zhurn. Vyssh. Nerv. Deyat.*, 35, No. 1, 60-67 (1985).
5. F. Dolto, *Za Rubézhom*, No. 2, 21 (1990).
6. V. P. Zinchenko, "Spiritual rebirth," *Chelovek*, No. 2, 5-15 (1990).
7. A. M. Ivanitskii, "Reflexes of the human brain: from stimulus to recognition and from decision to action," *Zhurn. Vyssh. Nerv. Deyat.*, 40, No. 5, 835-841 (1990).
8. I. Kant, "Analytic Essence of the Beautiful," in: *Collected Works in Six Volumes, Vol. 5* [Russian translation], Mysl', Moscow (1966).
9. É. A. Kostandov, "Consciousness and unconsciousness as a problem of the physiology of higher nervous activity of man," *Zhurn. Vyssh. Nerv. Deyat.*, 34, No. 3, 403-411 (1984).
10. A. R. Luriya, *The Bases of Neuropsychology* [in Russian], Izd-vo MGU, Moscow (1973).
11. A. Markusha, "Frankly speaking," *Nauka i Zhizn'*, No. 3, 63-67 (1979).
12. I. P. Pavlov, *Complete Collected Works, Vol. 3, Book 1* [in Russian], Izd-vo AN SSSR, Moscow; Leningrad (1951).
13. I. P. Pavlov, *Pavlov's Clinical Wednesdays, Vol. 1* [in Russian], Izd-vo AN SSSR, Moscow; Leningrad (1954).
14. P. V. Simonov, *The Emotional Brain* [in Russian], Nauka, Moscow (1981).
15. P. V. Simonov, *The Motivated Brain* [in Russian], Nauka, Moscow (1987).
16. P. V. Simonov, P. M. Ershov, and Yu. P. Vyazemskii, *The Origin of Spirituality* [in Russian], Nauka, Moscow (1989).
17. S. Freud, *The Psychology of Unconsciousness* [Russian translation], Prosveshchenie, Moscow (1989).
18. E. Fromm, "The necrophiles and Adolf Hitler," *Vopr. Filosofii*, No. 9, 69-160 (1991).
19. P. Fraisse, "Unity and diversity in the behavioral and natural sciences," *Ann. Theor. Psychol.*, 5, 213-240 (1987).
20. H. Kendler, "A good divorce is better than a bad marriage," *Ann. Theor. Psychol.*, 5, 55-89 (1987).
21. D. Price and J. Barrell, "Some general laws of human emotion: interrelationship between intensities of desire, expectation and emotional feeling," *J. Person.*, 52, 389-409 (1984).
22. M. Volkenstein, "On the freedom of will," *J. Social a. Biol. Structures*, 3, 67-72 (1980).
23. M. Yella, "Toward a unified psychological science: the meaning of behavior," *Ann. Theor. Psychol.*, 5, 241-274 (1987).