

REVIEW

The physiological conception of thinking based on the results of psychostereotactic operations

Nadvornik P, Bernadic M

Department of Neurosurgery, Faculty of Medicine, Masaryk University, Brno, Czech Republic.
marian.bernic@fmed.uniba.sk

Abstract: The authors have gained their experience in psychostereotactic operations during the past 50 years. The operations were indicated in psychiatric patients on the basis of their clinical pictures. The results gained in operations of the hypothalamus, limbic system and neocortical structures of the brain were logically analysed and served as the basis for physiological conception of the function of the nervous system in the area of thinking.

The elemental thinking of the hypothalamus resides in relatively simple memory that contains standard values of the internal environment of the body.

The immense memory on the highest neocortical level of the human brain grew to become an independent degree of development independent of the objective reality.

The entrance of physiological thinking into psychology enables to clarify the aspects of human psychology that are still liable to subjective view, such as emotions, motivation or consciousnesses (*Fig. 1, Ref. 9*). Full Text (Free, PDF) www.bmj.sk.

Key words: physiology of thinking, memory, evaluation of stimuli, selection, prediction, decision

Everybody understands subconsciously the meaning of the concept of “thinking”. Also the concept of “thought” that represents the result of thinking expressed in words or deeds is understood. However, the essence of thinking and the question as to how the brain really thinks remains largely unclear.

The experience gained in surgical, especially stereotactic interventions in brain structures has triggered the effort to investigate the organisation of psychic activities of the brain.

Material, methods and results

During the fifty years of co-operation with expert psychiatrists and psychologists we have been given the opportunity to apply the operational stereotactic technique in 209 patients suffering from behavioural disorders on three developmental brain levels, namely hypothalamus, limbic system and neocortex. We have investigated thoroughly the effects of these interventions on tuber cinereum, mammillary body, amygdalae, hippocampus, substantia innominata, cingulum, area parolfactoria, nc. accubens, and the structures of the thalamus (nc. intergenicularis, anterior, dorsomedialis, lamina medialis, centrum medianum). The analysis of gained results was focused on the clarification of physio-

logical mechanisms of thinking that we consider to be the momentum of behaviour in each living organism.

Fifty-one patients were subdued to operation on hypothalamus due to their aggressive behaviour in coincidence with severe oligophrenia. The operation according to Sano (1) was focused on the posterior hypothalamus. The operational stimulation evoked sympathetic responses, especially those of increasing heart and respiration rates and the elevation of arterial blood pressure. Solely 12 patients were subdued to the operation on the anterior hypothalamus with a parasympathetic response to stimulation of tuber cinereum resulting in the sensation of heat in the lower half of the body and perspiration on the forehead. The patients were treated due to sexual deviation by use of the technique according to Roeder (2), due to obesity according to Eth (3) or due to uncontrolled alcoholism and addiction to toxic substances referred to as hedonia.

In general we have achieved satisfactory results. However, it was necessary to operate symmetrically on both sides because the stimulation evoked the same responses in each side, also after the exclusion of one of them. Apparently, the structure of hypothalamus is duplex.

An exceptional complication took place due to damage incurred to the mammillary body resulting in memory disturbances. Later however, the latter disorders have gradually withdrawn. Only the patients operated due to sexual deviation developed an increased craving for food, probably due to the damage incurred to the neighbouring alimentary centre that is located laterally. Therefore we have modified the operation by accessing the hypothalamus through the ventricles from the right.

Department of Neurosurgery, Faculty of Medicine, Masaryk University, Brno, Czech Republic, and Department of Pathophysiology, Faculty of Medicine, Comenius University, Bratislava, Slovakia

Address for correspondence: M. Bernadic, MD, PhD, Inst of Pathophysiology, Faculty of Medicine, Comenius University, Spitalska 24, SK-813 72 Bratislava, Slovakia.

Phone: +421.2.59357287, Fax: +421.2.52965400

The logical analysis of results implies that the anterior hypothalamus is responsible for two basic radicals of behaviour, first of them being alimentary focused on the subsistence of the individual, the second being sexual focused on the continuance of breed. The attack reactions or the effort of achieving objectives in general are the executive radicals necessary for their satisfaction.

The physiological function of the hypothalamus is to maintain the standard internal environment values saved within the memory of organisms. Thus, in case of the alimentary instinct, the decrease in level of blood glucose is analysed by the hypothalamus as a negative stimulus and subsequent commands to recover the glycaemic balance is submitted to subordinated metabolic mechanisms.

In brief this means that the elementary thinking of the hypothalamus is based on several simple operators: memory, evaluation of stimuli resulting in a binary outcome, and the consequential decision to act addressed to subordinate executive systems. The stereotactic interventions are focused especially on the mechanism of memory and the evaluation of the stimulus.

The development of higher levels of the brain, namely the limbic system and neocortex have widened substantially the basic radicals of behaviour and therefore the original association with the function of the hypothalamus can be possibly neglected. According to Pavlov (4) the fact that millions of people work in order to earn their living is basically the instinct of alimentation. The sexual instinct that develops after the puberty enables to overcome the natural repulsion to a strange individual. Love then enables to bring people closer to each other, and mutual inclination and attraction result in the fact that people with similar ways of thinking form groups whose opinions become philosophic views of entire societies.

Similarly, the system of memory has been substantially widened enabling to record the experience and gained knowledge. The physiologic imagination of thinking has turned to become psychological and subjective.

154 patients were subdued to operations of limbic structures. The operations were indicated due to aggression as well as due to more moderate manifestations as e.g. erethism and hyperactivity. They were accompanied also by other behavioural disorders especially those coinciding with epilepsy or psychopathies, e.g. increased libido and sexuality. Later, the operations were indicated due to serious neuroses, especially those of obsessive-compulsive nature associated with phobias and anxieties.

The achievement of good and stable results by stereotactic interventions was not easy. Therefore the interventions in various subcortical structures were performed in particular combinations and sequences. Symmetric, bilateral and extensive operations were more effective, especially those focused on the cingulum in neurotic patients, as the latter structure is related to emotional evaluation.

The physiologic aspect of results of the analysis interfered with the psychological approach that was still prevailing. However, we have derived our opinion from the certainty that the basic operators of thinking used by the hypothalamus, namely memory and the analysis of stimuli linked with the decision to

act drawing near to psychological motivation, must be effective also within the limbic system because the functions of the identical brain are involved.

We have derived our work from successful results of Chitmondth (5) who in cases of smell hallucinations proposed to operate on the amygdalae. We have repeated his experience in a patient whose smell hallucinations evoked anancastic reactions of obsessive washing and redressing due to the imaginary sensation of unpleasant odour of her body.

We have gained courage to proceed similarly in cases with sight and hearing hallucinations associated with variously intensive aggression. However, we have proceeded in our own way by operating on the intergenicular space of the thalamus (6). This procedure was justified by the functions of sense analysers that project the real environment into the memory of the brain by form of real imaginations. The objective reality thereby turns into virtual reality where hallucinations take place also in cases when stimuli become virtual.

Six of the patients who developed various forms of aggressive behaviour due to hallucinations showed distinct results of operations that had been focused on affecting the aggression. Hallucinations and the consequential aggression disappeared in four of them after the operation on the thalamus, however the patients were able to lose their temper to an appropriate extent in coincidence with other stimuli. In two of them, the operation of hypothalamus has eliminated the aggressive behaviour entirely despite the fact that the hallucinations remained. This means that the functionally higher structure, as known already within the hypothalamus, decides to act, however the action is carried out by subordinate structures in their effort to fulfil the order by means of their own executive mechanisms.

The thinking on higher level of the brain begins therefore again by the evaluation of the stimulus. However it is not binary as it is carried out through a whole scale of sensations ranging from pleasant, indifferent to unpleasant feelings, and the behaviour changes according to the selection of decision based on experience from the past recorded in memory. It must be admitted that a new operator of thinking has been involved following the evaluation of the stimulus, namely the selection based on experience. According to this selection the response takes place.

The function of the highest neocortical level of the brain resides in the enormous, nearly inexhaustible memory. It records all concrete imagined pictures yet only in form of signs, abstract terms and words linked in compliance with grammar rules, enabling the specific human conceptual thinking. Hence, the memory records the entire experience and knowledge gained during the whole individual life or rather it records the model of individual world forming the basis of all thinking operations as well as the common base of consciousness.

It is difficult to imagine as to how stereotactic interventions can affect therapeutically particular disorders. Therefore we have decided to influence the functional structures of this level by means of the transplantation of human embryonic tissue.

We performed the operation at the same time as Dr. Madrazzo (7), however independently from his Mexican group and for the

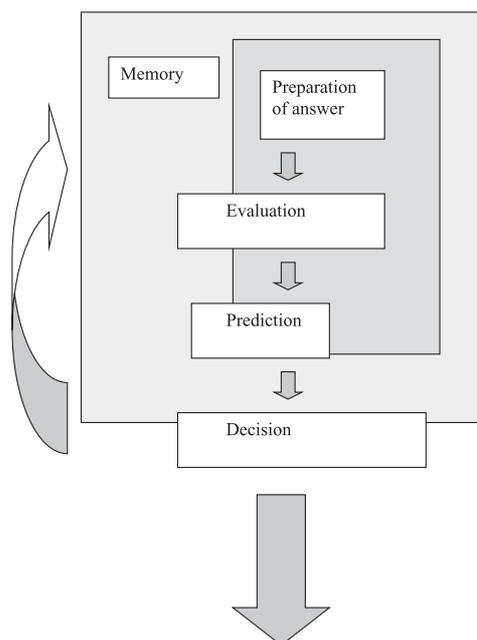


Fig. 1. The probable scheme of thinking on the highest level of the brain.

first time in the world in coincidence with schizophrenia (8). The graft of serotonergic tissue from the raphe of the brainstem of an embryo was laid bilaterally into the parolfactor area of the brain in the proximity of *nc. accumbens* in four patients in acute and chronic stage of the illness.

For example, a student in her acute stage of schizophrenia gained a feeling of being different from her classmates. She felt to be incapable, needless, and dull. Her feelings of inferiority were accompanied by egocentric feelings that she was watched by people from her environment who wanted to harm her. At the time of her admission to hospital she was apathetic and preferred being alone. Her speech was incoherent. The psychological examination revealed a marked decrease in her intellectual functions, especially in the component of memory.

Up to two months after the transplantation her health state began to recover. She became interested in her future and her memory recovered to a surprisingly high extent. She finished her studies at a medical school and started to work in a laboratory.

A 50-year old patient in a chronic stage of schizophrenia was subdued to operation. She was a good student, graduated at an economic school and worked for a savings company. When she was thirty, she started to worry that she had been watched and harmed. She started to accuse her colleagues and changed her attitude toward them. The psychiatric examination revealed paranoid schizophrenia. The patient was treated by dozens of electric shocks and ataractic drugs. She was relieved of legal liability and spent her last years in an institute. She did not remember anything and was mindlessly euphoric and bradypsychic.

A marked change took place in her behaviour seven months after the transplantation. For the first time of her stay at the insti-

tute she asked for postal paper and wrote several letters to her friends. One of them wrote her back and enclosed a bank note as pocket money. The patient refused the accusation that she had asked for financial support and asked a nurse who had read the letters to witness the truthfulness of her predications.

The surprising and unexpected behavioural changes in both cases were explained by the recovery of memory functions. The thorough analysis of behaviour has convinced us that the basic operators of thinking, namely the evaluation and decision to act operating in concrete thinking on the limbic level participate to the same extent also in conceptual thinking. It seems however that one more operator must be involved. Without the latter, the student patient could not have shown interest in her future education, graduation and employment, or the elderly woman could not have prepared an unexpected plan of her successful defence.

This means that after the recovery of their memory, both patients had to predict their future activities and to act accordingly. The objectives are set in the memory and evaluated as real stimuli that are to be fulfilled. Here, also the information can become a stimulus.

Therefore, the prediction involving the analysis and synthesis of facts is considered to be the main manifestation of intelligence.

The probable scheme of thinking on the highest level of the brain is presented in Figure 1.

Discussion

The psychological effort to define the concept of thinking was formerly associated with the unsuccessful struggle to define the complex concepts of sense and intelligence.

Later, the concept of thinking referred to the solution of problems based on the transition from known to unknown facts, the procedure of which forms the highest degree of the process of recognition. Similarly, it referred to the relation between the subject and the object in problematic situations with the use of memory. Under the influence of cybernetics, the concept of thinking was comprehended as the manner of information processing (9, 10, 11).

However, the psychological considerations and judgements can be still referred to only in form of their sententious description, however without their relation to the respective physiological brain activity.

An opinion is accepted, namely that the thinking takes place in form of associations by linking psychological processes with their results of conceptions and imaginations. Should various stimuli "S" form the response "R" on the basis of thinking dependent on the personality of the subject "O", the following formula is applied:

$$R = f/S;O/$$

The function of thinking here performs as the momentum of behaviour, the fact of which can be agreed with (12).

However, this is a general expression and does not assess the mechanism of thinking, i.e. the way by which the stimulus turns

to response. Therefore the described physiologic operators of thinking assumingly are going to face the psychological conceptions of the behaviour of the subject. It may be expected that the clarification of some psychological terms as the function of emotions, motivation or consciousness will bring both aspects closes. However, mutual respect of opinions is required so far.

References

1. **Sano K.** Sedative neurosurgery with special reference for posteromedial hypothalamotomy. *Neurol Med Chir* 1962; 4: 112—142.
2. **Roeder FD.** Stereotactic lesions of the tuber cinereum in sexual deviations. *Confin Neurol* 1966; 27: 162—163.
3. **Eth S.** Stereotaxy for obesity. *Lancet* 1974; 4: 867-868.
4. **Pavlov IP.** Sebrané spisy. SZN Praha 1953, 314.
5. **Chitmondh H.** Stereotactic amygdalotomy in the treatment of olfactory seizures and psychiatric disorders with olfactory hallucinations. *Confin Neurol* 1966; 27: 191—196.
6. **Nadvornik P, Pogady J, Šramka M, Patoprstá G.** Stereotactic treatment of some psychoses. Survey of results. *Activ Nerv Sup* 1974; 16: 335.
7. **Madrizzo I, Leon V, Torres G.** Transplantation of fetal substantia nigra and adrenal medulla to the caudate nucleus in two patients with Parkinson disease. *New Engl J Med* 1987; 318: 51—62.
8. **Kolarik J, Nadvornik P, Tabarka K, Dvorak M.** Transplantation of human embryonic nerve tissue into a schizophrenic brain. *Zbl Neurochir* 1988; 49: 147—150.
9. **Nadvornik P, Bernadič M, Drličková V.** Fyziologie mozku a jeho myšlení. Bratislava: SAP 2009, 114 pp.
10. **Nadvorník P, Čierny G, Bernadič M.** Considerations on physiological mechanisms of spinal cord movement performance according to cerebral stimuli. *Bratisl Lek Listy* 2007; 108 (12): 529—532.
11. **Nadvorník P, Pogády J, Bernadič M.** Návrh fyziologické koncepcie myšlení odvozený z výsledků psychostereotaktických operací. *Čs Fyziol* 2003; 52: 79—82.
12. **Pogady J, Zucha I.** *Psychopatologia*. Faber Bratislava 1996, 192.

Received February 24, 2009.

Accepted June 26, 2009.