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## **L.S. Vygotsky and the Problem of Functional Localization**

Forty years ago, in the middle of the 1920s, a young Soviet psychologist, still under thirty, came to the Clinic of Nervous Diseases, at first to observe, later to conduct his own independent research. His name was L.S. Vygotsky.

Unlike many others, including Professor G.I. Rossolimi, the director of the clinic, he had not come to carry out psychological tests for perfecting diagnoses of brain diseases. His task was incomparably wider: he saw the analysis of local brain infections as a basic means for solving fundamental questions of the structure of mental processes and of the material substratum of complex forms of mental activity. Some years later he wrote: “It seems to me that the problem of localization, like a common channel, includes the examination of both the development and the disintegration of higher mental functions.” This was in a lecture he read six weeks before his death: “The Problem of the Development and Disintegration of Higher Mental Functions” [Problema razvitiia i raspada vysshikh psikhicheskikh funktsii. In L.S. Vygotsky, *Razvitie vysshikh psikhicheskikh funktsii* [Development of Higher Mental Function] (Moscow: Akad. Pedag. Nauk RSFSR, 1960), p. 383].

Vygotsky approached the problem of localizing mental functions from a well-thought-out innovative stand, which from the outset was opposed to the basic psychological and neurological tenets of the time.

Psychology of the 1920s was monopolized by the idea that human mental life was a complex of “functions” or “properties” common to man and animals. Leading psychologists of the time regarded sensations and perceptions, attention and memory, judgment and deduction, emotions and voluntary ac-

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tions, as natural manifestations of the working of the nervous system, or, at best, as processes with a reflex structure whose mechanisms were carefully studied in the conditioned reflex activity of animals. This came only shortly after the period of domination of dualism, when the crucial question for psychology had been whether mental and physiological phenomena were “parallel” or “interactive.” Therefore, the naturalistic approach to mental phenomena, which had been the point of departure both for German Gestalt psychology and American behaviorism, was not only approved but also enlisted the most progressive wing in psychology.

Naturally enough, however, after successfully solving a number of important questions of the mechanisms of elementary mental processes (sensations and the simplest forms of perception, involuntary attention and spontaneous memory) the “naturalist”-psychologists could not begin to approach questions of the mechanisms that lay at the root of specifically human *higher mental functions*. How can one understand the mechanism of a voluntary act? What are the characteristic ways in which voluntary attention and active memory work? How can one approach the scientific analysis of abstract forms of thought that allow man to penetrate the deepest connections of reality? At the time an attempt was made to answer all these questions by idealistic “descriptive psychology”—understood as the “science of the spirit” [*dukh*—which took up these questions while rejecting their genuinely scientific, materialist analysis.

Our young Soviet psychologist’s point of departure differed radically from these views.

In Vygotsky’s view, higher mental functions, which the naturalistic school had refused to study, must not only be the subject of causal analysis; such an analysis must be the *basic task* of scientific psychology. To retain the natural scientific approach and reject this examination would mean to arrest scientific progress and direct it along false lines. However, the spiritualist psychological approach is just as unacceptable: to retain the question of higher forms of consciousness and will, but to reject the scientific analysis of the genesis of these phenomena, would mean the substitution of fideistic philosophy for science.

Vygotsky saw the way out of “the historical crisis of psychology”<sup>1</sup> in a radical reappraisal of basic psychological concepts. “Higher mental functions” must have an origin; but this origin must not be sought in the depths of the spirit or hidden properties of nervous tissue: it must be sought outside the individual human organism in objective *social history*. In forming society and using tools, man created new, indirect forms of relationships to the external world to which he had formerly accommodated himself and which he now con-

trolled. The formation of language during the process of social development provided him not only with a new, hitherto unknown method of communication but also with a new tool for ordering his mental processes. The higher mental functions that originated in social labor and speech enabled man to rise to a new plane of organization in his activity. By adapting the methods created for verbal communication to his own needs, he developed those forms of intelligent perception, voluntary attention, active recall, abstract thought, and voluntary behavior that had never existed in the animal world and that have never to any extent shown themselves as primordial properties of the "spirit."

To approach human mental life from this angle entailed a radical reorganization of all the basic areas of psychology. Perception and memory, imagination and thought, emotional experience and voluntary action ceased to be considered as natural functions of nervous tissue or simple properties of mental life. It became obvious that they have a highly complex structure, and that this structure has its own sociohistorical genesis and has acquired new functional attributes peculiar to man. Speech activity ceased to be regarded as an isolated process only indirectly connected with perception, attention, memory, and thought. It actually became possible to explain the processes of abstract thought and voluntary action scientifically. What had previously been regarded as isolated "functions" or even irresolvable properties, now emerged as highly complex *functional systems* formed in the past and changing in the course of lifetime development. When communicating with adults, reorganizing his behavior on the basis of objective activity and speech, and gaining knowledge, a child not only acquires new forms of relationship to the external world, but also works out new ways of regulating his behavior and establishes new functional systems enabling him to master new forms of perception and recall, new ways of thinking, and new methods for organizing voluntary actions.

Vygotsky's ideas radically altered our view of the nature and structure of mental processes. Fixed and immutable "mental functions" were transformed into complex and mobile functional systems that change during development; psychology emerged from its constricting naturalistic boundaries and became the science of the social formation of natural phenomena.

However, one question, and perhaps the most essential, remained open: how is the material substratum to be understood? What conceptions of the working of the brain should underlie our view of the material bases of mental activity?

The problem of localizing mental functions in the cerebral hemispheres (and the question of the cerebral bases of mental activity was formulated in precisely this way) underwent a period of acute crisis in the 1920s, reflecting

to a large extent the general crisis in psychology. On the one hand, neurology continued to assert its naive ideas of the localization of complex mental functions in limited areas of the cerebral cortex—ideas originally crystallized in the great discoveries of the 1870s. Arising from these simplified views of mental functions then current in psychology, neurologists assumed that in addition to the cortical sensory and motor “centers,” analogous centers could be found for more complex mental processes. As a result of the writings of Lissauer, Henschen, and Kleist, the idea of “perceptual centers,” “calculational centers,” and “conceptual centers” in the cerebral cortex did not seem in the least bit extraordinary.

Naturally enough, however, these views of restricted localizationism gave rise to serious doubt. Aware of the complexity of human higher mental processes and taking into account the well-known clinical fact that they could be disrupted by injuries in widely varied locations, many neurologists assumed that complex forms of mental processes were the result of activity of the brain as a whole. Some of these authors, adhering to the holistic viewpoint (Monakov, Grunbaum) under the noticeable influence of the Würzburg school of psychology, held aloof from all attempts at a closer examination of the cerebral apparatuses connected with higher forms of mental activity. Others, supporting Gestalt psychology (K. Goldstein), attempted to construct a hypothesis of an excitation structure evenly distributed throughout the cortex, and to see the basis of complex forms of human mental activity in these featureless “structural” processes. While accepting a restricted localization of elementary physiological processes in limited areas of the cortex, they rejected in practice all concrete analysis of the critical zones that take part in the execution of complex forms of human mental activity. “Revolving in a vicious circle of structural psychology,” wrote Vygotsky, “examination of the localization of specifically human functions vacillates between the poles of extreme naturalism and extreme spiritualism” (*Razvitie vysshikh psikhicheskikh funktsii*, p. 386).

The idea of higher mental functions as social in origin, systematic in structure, and dynamic in development, which Vygotsky took as his starting point, naturally could not be contained in the patterns described, and a new, radically reorganized approach to their cerebral localization was required.

The fact that no mental function could be understood as a simple “property” of mental life forced from the outset the rejection of the idea that higher nervous processes were represented in the cortex in the same way as elementary physiological “functions”; however, concrete ideas as to their complex differentiated composition had already rejected as fruitless the conception of the brain as a single undifferentiated whole at the foundation of such functions.

The ideas that Vygotsky arrived at made him think that “localization of higher nervous functions can only be understood chronogenically, as the result of mental development,” that the relationships characteristic of the separate parts of the brain that fulfill higher mental functions “are formed during the process of development,” and that “the human brain possesses new localized principles as compared to an animal’s brain” (*Razvitie vysshikh psikhicheskikh funktsii*, p. 382). However, this discovery required a much fuller and more concrete analysis of the functional organization of human mental processes, for without this, all attempts at solving the problem of localization would be impossible.

In his earlier experiments (see his *Izbrannye psikhologicheskie issledovaniia* [Selected Psychological Investigations] [Moscow: Akad. Pedag. Nauk RSFSR, 1956]; and *Razvitie vysshikh psikhicheskikh funktsii* [Moscow: Akad. Pedag. Nauk RSFSR, 1960]), Vygotsky had already considered the fact that a child’s mental development is not a simple maturing of natural “instincts,” but that it occurs in the process of objective activity and communication with adults. The child masters the tools developed in human history and learns to make use of external *means* or *signs* to organize his own behavior. While an animal’s response reactions are produced by stimuli arising from its external or internal environment, a child’s actions very quickly start being directed by signals that he creates himself and that he obeys. The child’s direction of his attention by means of his own speech signals, and his organization of his activity through the regulation first of external and later of internal speech, serve as examples of mediated organization of his mental processes. Only gradually does this overt activity, which relies on the external environment, contract and acquire a covert character, turning into those internal mental processes that can appear as simple and irresolvable “mental functions” but that, in fact, are the product of highly complex historical development.

Naturally such a mediated, “instrumental” type of behavior, which is peculiar to man and absent in animals, makes one assume a new principle in localizing higher mental processes as distinct from those forms of cerebrally organized behavior found in animals. This is why Vygotsky speaks of the role of “extracerebral connections” in localizing functions connected with specifically human areas of the brain (*Razvitie vysshikh psikhicheskikh funktsii*, p. 391). These are formed in man’s external activity, in the use of tools and external signs, which are so important to the formation of higher mental functions. Human practical activity is impossible to imagine without an objective, as is verbal thought without language and its external devices, speech sounds, letters, and logico-grammatical constructions, created in the course of social history.

Social history ties the knots that produce new correlations between certain

zones of the cerebral cortex, and if the use of language and its phonetic codes gives rise to new functional relationships between the temporal (auditory) and kinesthetic (motor-sensory) areas of the cortex, then this is the product of historical development relying on “extracerebral connections” and forming new “functional organs” in the cerebral cortex (see A.M. Leont’ev, *Problemy psikhicheskogo razvitiia* [Problems of Mental Development] [Moscow: Akad. Pedag. Nauk RSFSR, 1959]).

However, the fact that in the course of history, man has developed new functions does not mean that each one relies on a new group of nerve cells and that new “centers” of higher nervous functions appear like those so eagerly sought by neurologists during the last third of the nineteenth century. The development of new “functional organs” occurs through the formation of *new functional systems*, which has never happened in animals and which is a means for the unlimited development of cerebral activity. The human cerebral cortex, thanks to this principle, becomes an organ of civilization in which are hidden boundless possibilities, and does not require new morphological apparatuses every time history creates the need for a new function.

The study of systematic localization of higher mental functions thus removes the contradiction between the ideas of restricted localizationism and notions of the brain as a single whole. Each specific function ceases to be thought of as the product of some center; on the other hand, the function of the brain as a whole ceases to be presented as the work of an undifferentiated and uniform mass of nervous tissue. Both ideas have been replaced by that of a system of highly differentiated cortical zones working simultaneously and accomplishing new tasks by means of “inter-center” relations. These ideas, established by Vygotsky, have provided the basis for the study of systematic or dynamic functional localization, which now, thirty years after the author’s death, have been thoroughly incorporated into modern science. (See A.R. Luria, *Vysshie korkovye funktsii cheloveka* [The Higher Cortical Functions of Man] [Moscow State University, 1962].)

However, there remains one vital aspect of Vygotsky’s study of systematic localization of mental functions that still requires concrete experimentation. This is the question of dynamic change in the correlation of cerebral “centers” during development and disintegration, which opens up new horizons for the extended study of “chronogenic localization” of functions in the cerebral cortex. Neurology had never considered the question that the same functions, at different stages of development, could be executed by different parts of the cortex, and that the interaction of different cortical zones could vary at different stages of development. This is the conclusion Vygotsky reached after a careful study of the developmental pattern of higher mental functions in ontogenesis. This was a completely new idea for neurology.

In tracing the early stages of ontogenesis, Vygotsky showed that the first steps in forming higher mental functions depend on more elementary processes that serve as a base. Complex concepts cannot be developed if there are insufficiently stable sensory perception and ideas; voluntary recall cannot be formed if there is not a stable substratum of immediate memory. However, in later stages of mental development, the relationship between elementary and complex processes changes. Higher mental functions developing on a base of elementary mental processes begin to influence the base, and even the simplest forms of mental processes are reorganized under the influence of higher mental activity; it is enough to recall the part played by verbal classification in color perception to understand the full depths of this process.

These facts compelled Vygotsky to assume that the relationship between separate cortical zones changes during development, and, if, initially, the formation of “higher” centers depends on the maturity of the “lower;” ultimately the “higher” centers organize and influence the “lower” in fully formed behavior. This inverse correlation of cortical areas at different stages of development, according to Vygotsky’s theory, means that *injury to one particular cortical area may lead to extremely different syndromes at different stages*. If injury to the cortical zones in question in the early stages of development leads to underdevelopment of the *higher* sections forming on this base, after maturity it is the *lower* systems dependent on these zones that are affected by injury. This assumption makes it clear that injury to the gnostic zones of the cortex in early childhood leads to general mental underdevelopment, while in an adult it gives rise to isolated symptoms of agnosia, which can—within certain limits—be compensated for by the undamaged higher systems of the cortex.

The assumption that a change occurs in relations between centers in subsequent stages of ontogenesis added a new dimension to the study of dynamic localization of mental functions, but it will only be the next generation of investigators who will be able to estimate the full import of this brilliant foresight.

Vygotsky’s research of the late 1920s into the development of higher mental functions, the changes occurring in them under abnormal conditions, and their disintegration in the presence of cerebral injury laid the foundations for a new area of science, neuropsychology, which has only recently established itself. His last work, published posthumously, “Psychology and the Localization of Mental Functions” (notes for a lecture that he was fated never to deliver), was the first and fullest program for investigating the functional organization of the human brain, the organ of human consciousness.

This was one of the greatest contributions to science of that outstanding investigator—L.S. Vygotsky.

## Note

1. He made a special analysis of this crisis, which has not been published.

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[Prepared by the editor. (This bibliography is not complete.) Alternative transliterations in the non-Russian literature are Vygotsky, Vygotskii, Vygotskiy, Vygotskij, Vygotsky, Wygotski, and probably others as well. For a biography of Vygotsky see *Handbook of Soviet Psychology, Sov. Psychol. Psychiat.*, 1966, vol. 4, nos. 3–4, pp. 111–12.]

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