A. R. Luria

The long road of a Soviet psychologist

The main activity in the scientific life of the present writer is his role in helping to create a new branch of science—neuropsychology, the analysis of the origins within the brain of man's mental activity and the application of psychological methods to the study of the functional organization of the brain. The theoretical significance of this new branch lies in the fact that it enables a closer analysis to be made of the nature and internal structure of man's mental processes. Its practical importance resides in the fact that it provides a scientific basis for the diagnosis of local lesions of the brain and for the restoration of complex forms of mental activity disturbed by these lesions.

The road leading to the creating of this new branch was not an easy one; it called for a revision of the basic approaches to cerebral activity in man and of the fundamental principles of classical psychology. The eminent Soviet psychologist L. S. Vygotskij (1896–1934) was the first to set out on this road, and I consider my own work to be merely a further step in the same direction.

Science at the end of the nineteenth century had a deep-rooted naturalistic conception of the brain and its activity that has persisted until recently.

Research scientists considered that the human brain had certain inherent properties which enabled it to carry out mental processes. Some authors thought the brain to be a complex assembly of small organs or 'centres', each with its own strictly defined functions, and they located special 'centres' in the cerebral cortex governing such functions as speech, writing, reading and counting; others believed the brain to be a unified mechanism functioning as an indivisible whole. In spite of the apparent difference between the two groups of scientists, however, both of them supposed that the various forms of mental activity are a direct result of brain functions and that mental processes are generated by separate nerve cells (neurons), and occur as a direct consequence of those cells' activities.

This supposition appeared so obvious that it was even shared by leading figures in the field of modern physiological theory: C. Sherrington, E. Adrian, J. Eccles, etc.

That mental processes are the direct 'properties' of nerve-cell activity and that they can be approached from the standpoint of naturalistic analysis was by no means self-evident

However, the notion that mental processes are the direct 'properties' or 'manifestations' of nerve-cell activity and that they can be approached from the standpoint of naturalistic analysis was by no means as self-evident as might have been supposed at first sight.

This approach did not, it is true, come up against any serious difficulties in the analysis of elementary mental processes. Visual sensations are clearly the result of processes taking place in the retina of the eye and the 'visual' brain centres linked to it; indeed nerve cells have recently been found in the section of the cortex relating to visual sensations (located in the occipital area) which respond only to light stimuli—and, moreover, only to light stimuli of a certain type. Again, it is quite evident that auditory sensations are generated when nerve cells in the mechanism of the inner ear and the associated 'auditory' neurons in the cerebral cortex are excited, while tactile sensations are the result of irritation of skin nerve cells whose excitation is transmitted to very specific areas of the brain.

However, can the same principle be applied to the higher forms of man's conscious activity? Are we to suppose that there are special nerve formations in the cerebral cortex which give rise to the perception of objects, voluntary action and conscious experience?

It is evident that man lives in a world of objects which he perceives and that he receives information regarding the experience of generations of other individuals; he is capable of forms of conscious, willed activity which distinguish him from animals. Man sets himself goals, formulates plans and programmes for his behaviour, regulates his actions, controls them as they proceed and corrects his mistakes.

Is it conceivable that these conscious forms of mental activity, whose existence is undeniable, are 'generated' by specific brain cells in the same way as the most simple sensations or elementary movements?

Classical psychology rejected this supposition from the very beginning; it held that the higher mental functions are intellectual rather than material in origin, that they are not generated by the brain but merely reveal forms of the intellectual universe and that they proceed 'in parallel' with the brain or 'interact' with it.

However, these notions, which have persisted until very recently, present insurmountable obstacles from the point of view of scientific positivism and the study of the brain.

Psychologists, recognizing the peculiar nature of the higher forms of conscious activity but relating this activity to a special intellectual universe, are compelled to divide psychology into two completely separate sciences: one to provide an explanation of the elementary mental processes without attempting an equally scientific approach to the analysis of the higher forms of mental activity, and the other to provide a description of the higher forms of man's

We still know very little about the formation of mental processes in the course of the historical development of society

intellectual life without attempting to give a scientific explanation of them. At the end of the nineteenth century, these two branches were termed 'explanatory psychology' (*erklärende Psychologie*) and 'descriptive psychology' (*beschreibende Psychologie*) respectively.

The consequences of this hiving-off of the higher or intellectual mental processes are equally embarrassing for cerebrophysiologists. Being unable to explain the origin of the higher forms of conscious activity, they either revert to a crudely materialistic approach that has long been obsolete and attempt to find separate neurons, located somewhere in the deeper regions of the brain, which 'generate' consciousness, or they look for the point where 'the mental principle enters the brain', attempting to discover minute 'detectors' of the intellectual universe in the brain tissue (cf. J. Eccles, 1966/70).

It is essential to resolve this basic contradiction and to find a principle that will allow equally scientific methods to be adopted for the analysis of both elementary and higher mental processes and make it possible for contemporary science to solve the problem of their organization within the brain.

The Soviet psychologist L. S. Vygotskij attempted to deal with this fundamental problem of psychology and the solution he offered for a long time determined the development of scientific psychology; more especially, it was of fundamental importance for the particular branch of that discipline which I myself have attempted to carry a stage further.

Vygotskij (I first met him in 1923 and continued to work closely with him until his death) based his approach on a simple but radical principle, that man's higher mental processes have a social rather than a natural origin and in order to explain them it is necessary to go beyond the organism and to look for their roots in relations between individuals and in the historical conditions of a society.

We still know very little about the formation of mental processes in the course of the historical development of society although much is known about the formation of higher mental functions—conscious action, voluntary attention and active perception—in the development of the child.

The child grows up in a world of objects which have been formed as a result of a society's labour; he lives in unbroken contact with adults. A mother says to a child, 'This is a ball', and points to it with her finger; the gesture and the word direct the child's glance, distinguish the object from its surroundings and draw attention to it. The mother says: 'Give me the ball' and the child performs the necessary action. The contact between the child and the adult lies at the basis of the complex forms of voluntary action. The complex mental functions—conscious, voluntary action—is initially divided between the two individuals; it is initiated by the mother and completed by the child.

The child then learns to speak; he now repeats the mother's verbal instruction himself. He himself says, 'This is a ball', and in obedience to his own utterance directs his glance on to the named object and picks it up. A function which was

previously divided between two individuals now becomes an internal form of organization of the child's mental activity. It is in this way that the higher mental functions come into being: social in origin, mediate (through speech) in structure, conscious and voluntarily directed as to their method of operation.

This theory of the social origin and complex structure of man's higher mental functions radically changes our approach to their cerebral organization.

Attempts at narrow 'localization' of the higher mental processes in particular areas of the brain now appear meaningless. The higher mental functions begin to be seen as highly complex functional systems which involve a whole set of cerebral mechanisms and are not 'localized' in separate areas of the cerebral cortex but are found throughout the cortex, and depend on the extremely complex interaction of the various cortical zones, each of which plays a particular role in this 'functional system'.

The 'functional system' concept has nothing new or unexpected about it. It was introduced in psychology by L. S. Vygotskij and in physiology by the eminent Soviet scientist P. K. Anohin. It is based on the supposition that any complex activity—even if it is physiological in nature, such as breathing—fulfils a particular function (e.g. the transmission of air to the alveoli of the lungs), but employs a variety of different means in order to do so (innervation of the diaphragm, expansion of the thorax by the intercostal muscles, swallowing of air, etc.): if the constant (invariant) function is fulfilled, the activity ceases; if it is not fulfilled, signals on the discrepancy ('non-co-ordination') between the result of the activity and the initial task are transmitted to the brain and the search continues for the means necessary to fulfil the function.

If such comparatively simple 'functions' as breathing are essentially very complex 'functional systems', this is even truer in the case of 'higher psychological functions'. As has already been said, they come into operation through a process of complex reaction to reality and contact with surrounding individuals; they include not only active, practical 'doing' but also speech, which is initially a means of communication and is subsequently applied to the internal organization of man's mental processes.

It is natural, therefore, that the cerebral basis of these higher forms of man's mental activity should take the form of extremely complex functional systems of simultaneously activated cerebral zones, and that the location of these functional systems should constitute the fundamental problem of neuropsychology.

We have stated the fundamental problem of neuropsychology. In order to move nearer towards its solution, however, it was necessary to determine the structure of the higher mental processes themselves; only then would it be possible to look for the cerebral bases of their organization.

I stressed the need for a detailed study of the process by which the higher forms of mental activity develop in the course of a child's contact with adults

This problem was formulated by Vygotskij, and research on it was continued by his colleagues and students (A. N. Leont'ev, A. V. Zaporožvec, D. B. El'konin and the present writer).

Already in its early work this group, which exercised a considerable influence on the development of Soviet psychology, was able to demonstrate the extremely complex structure of such human processes as perception and attention, memory and thought, movement and action. Its central postulate, to which reference has already been made, was the role of speech—initially external, subsequently internal—in the formation of all these processes.

Vygotskij showed that the meanings which words acquire in the course of a child's activity develop, and that this process plays a decisive role in the development of cognition, thought and consciousness in man.

I myself set out to study another function of speech, namely, its role in the organization, regulation and control of man's voluntary movements and affective experiences. This was the subject of my first full-scale work, *The Nature of Human Conflicts* (1932), which summed up the results of my earlier researches on affective reactions, showed the conditions in which they occur, raised and analysed the role of speech in overcoming them and in the organization of voluntary movements.

This work marked the beginning of a whole lengthy series of research projects which I began in the 1930s and which were only completed twenty-five years later, at the end of the 1950s and beginning of the 1960s.

Already in my first publication, written jointly with L. S. Vygotskij, *Studies on the History of Behaviour* (*Etjudy po Istorii Povedenija*) (1930), I had stressed the need for a detailed study of the process by which the higher forms of mental activity develop in the course of a child's contact with adults, and of the vital role played by speech in this process.

It was not, however, until 1935/36 that I was able to undertake a special analysis of the role of speech in the formation of the higher mental processes. I had the opportunity of making a thorough study of the mental development of monozygotic twins and together with a colleague I published a special book entitled *Speech and the Development of Mental Processes* (*Reč' i Razvitie Psihičeskih Processov*), in which I showed the decisive influence of the development of speech activity on that of complex forms of perception and memory, thought and action. In a practically unique experiment on monozygotic twins whose speech development was extremely retarded, it was shown that separating the twins and introducing them into two different groups created a new stimulus for speech communication and led not only to rapid speech development but also to a reorganization of the higher forms of mental activity. It was possible to show at the same time that the special speech training received by one of the twins gave rise to forms of conscious activity which did not develop spontaneously in the other twin who did not undergo the special training. The results of this

experiment were so conclusive that the book *Speech and the Development of Mental Processes* was reprinted in 1959 and 1971 in a number of languages and has received a wide response.

A second research project on monozygotic twins, which unfortunately was only published in Russian (1948), involved an experiment in which a group of monozygotic twins was split up and their constructive activity was subjected to two separate forms of training; one of them was limited to visual activity while in the other included conscious analysis based on speech processes. This experiment showed how profoundly the processes of visual perceptive activity are transformed under the influence of the analysing and regulatory function of speech.

The main results of this series of investigations were summed up in a very brief article entitled 'The Development of Mental Functions in Twins' which I published in its original form in the review *Character and Personality* in 1938 and which was republished in a revised and enlarged form in 1962 in the journal *Voprosy Psihologii* (Problems of Psychology). This article, based on the results of a comparative study of changes in a number of morphological factors and psychological processes—memory in particular—in monozygotic and dizygotic twins, showed that while the influence of the genotype on certain morphological factors remains unaltered throughout ontogenetic development, this is not the case in regard to psychological processes. During ontogenetic development, processes such as memory change not only in regard to their psychological structure (change from direct memory to complex memory, with speech as an intermediary) but also in their relation to the genotype; in other words, changes in these processes depend less and less on hereditary factors and increasingly on the influence of the external (social) environment. Unfortunately, this article attracted hardly any attention, although I am convinced that the propositions it contains could open up new and important lines of research on the respective roles of genotypical and paratypical factors in the development of our mental processes as we grow up.

In subsequent years, my colleagues and I continued to study the role of speech in the formation of mental activity, research being divided into two complementary areas.

On the one hand, a whole series of special studies was undertaken on the genesis and formation of the regulatory function of speech, which has been totally ignored by linguists who have been concerned with the phonetic, lexical, sematic and grammatical aspect of language but have not even attempted to study the pragmatic function of speech, i.e. to analyse the role of speech in the cognition of programmes of behaviour, in maintaining the tone of and controlling behaviour. On the other hand, an analysis was made of how the regulatory function of speech changes in conditions of abnormal development.

The first project involved young children (of $1\frac{1}{2}$–2 to $3\frac{1}{2}$–4 years of age) and attempted to determine precisely how the child begins to obey an adult's ver-

Abnormal development too, could be described by indicators showing the interrelation of the neurodynamic features of general nervous and vocal forms of activity

bal instructions and how the regulatory role of his own speech constantly develops. This research, published in a series of special papers from 1958 to 1961, showed that in the child aged 1½–2 years the regulatory function of adult speech has a very limited effect on his behaviour and although it may easily provoke the desired reaction (drawing attention, performance of a required action), it cannot yet retard or inhibit a provoked reaction with any success and its effect is very easily curtailed by the action of indirect stimuli. It is only in the 3–3½-year age group that verbal instruction by the adult becomes so definite and persistent that it can give rise to fairly complex programmes of action and override extraneous influences. During this period the regulatory function of the child's own speech begins to develop, initially influencing his own external speech and subsequently being internalized and regulating his internal speech and the patterns of behaviour created on the basis of that speech.

My colleagues and I also studied the formation of the regulatory function of speech in older children, and the disturbance of this regulatory function of speech in regard to complex forms of behaviour was found to be one the fundamental signs of certain types of abnormal development. These data were included in a two-volume work which we published under the title of *Problemy Vyššej Nervnoj Dejatel'nosti Normal'nogo i Anomal'nogo Rebënka* (Problems of Higher Nervous Activity in the Normal and Abnormal Child) (Vol. I, 1956; Vol. II, 1958) and were later discussed in a special book entitled *The Role of Speech in the Regulation of Normal and Abnormal Behaviour* (Oxford, Pergamon Press, 1959). These publications showed that an objective indication of normal or abnormal development in the child is provided not only by general indications of change in nerve processes (their force, equilibrium, mobility), as the I. P. Pavlov school often considered to be the case, but also by special indications of neural changes in direct (non-speech) and speech systems; and that as soon as neural changes in speech processes begin to overtake neural changes in non-speech processes speech can assume a regulatory role in regard to the child's behaviour as a whole.

Our researches also revealed that abnormal development too, could be described not so much in terms of general changes in nerve processes but rather by indicators showing the interrelation of the neurodynamic features of general nervous and vocal forms of activity; and that while in the case of mentally retarded oligophrenic children the neurodynamic indicators relating to equilibrium and particularly mobility of the nerve processes underlying speech activity lag behind the indicators for non-speech behaviour, very much the opposite may be true in the case of children suffering from other forms of development disorder, especially asthenia.

These important results, which were mainly established by my colleagues, E. D. Homskaja, A. I. Meščerjakov, V. I. Lubovskij and others, shed new light on the problem of compensation for neurodynamic defects and suggested certain

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new approaches to the theoretical problems of the psychophysiology of child development.

These data were presented in their most general form in one of my most recent publications, a lecture entitled 'The Origin and Cerebral Organization of Conscious Processes' which I delivered in 1969 to the nineteenth International Congress of Psychology in London.

The series of investigations just described, which began in the 1930s and continued over three decades, showed the social origins and complex structure of higher mental processes, where speech plays a very important role. At the same time, these studies laid the foundation for my main activity, an analysis of the cerebral organization of complex mental processes, and for neuropsychology, a branch of science whose development would have been impossible without this research.

As early as the middle of the 1920s, I became interested with L. S. Vygotskij in the question of how man's mental processes change when the brain suffers lesions accompanied by the impairment of speech.

The relevance of this question, which called for a careful study of aphasia, was obvious and although the first experiments designed to analyse the intellectual behaviour of aphasiacs were extremely crude, the drawing of attention to this problem marks the beginning of a series of studies which were to lead to the creation of neuropsychology.

In those days the problem of the localization of mental functions, including speech, was formulated in a very simplified manner. As has been pointed out, certain authors (e.g. K. Kleist) considered that speech could be 'localized' in the same way as all mental processes in particular areas of the brain ('narrow localization'), while others such as C. von Monakow and K. Goldstein believed that the brain always works as a unified whole and paid little attention to analysing the precise contribution of each cortical zone to the formation of this whole ('anti-localization').

I was unable to subscribe to either of these views as both appeared to me to be equally erroneous.

If a 'higher mental function' (speech or any other) represents a complex functional system which is social in origin and mediate in structure, it seemed reasonable to present the problem in a different way and not to attempt to answer the question of where a particular 'function' was 'localized', but rather to analyse the 'distribution' of a particular functional system in the cerebral cortex and to determine the precise contribution of particular zones to the formation of this functional system.

Local lesions of the human brain (tumours, traumata, haemorrhages) were particularly useful in helping to solve this question.

It was already fairly apparent at this time that the human cerebral cortex has a complex hierarchical structure and that while the simplest, primary areas

are associated with very specific functions (occipital with visual, upper-temporal with auditory analysis of signals received), the secondary zones located above them have a more complex function, namely, to synthesize and organize these impulses and to transform these particular modal and specific processes into a complex functional organization; even more complex—tertiary—areas carry out a still more complex synthesis, combining various specific (visual, auditory, tactile) systems at higher supermodal levels of organization.

It was therefore a logical step to consider the problem of the precise role of these cortical zones in the formation of 'higher mental functions' and the exact nature of the impairment of these complex functional systems when the brain suffers local lesions.

Attempts to answer these questions were made throughout the 1930s and the 1940s and met with some success. They were based, in particular, on the study of a large number of cranial and cerebral wounds received during the Second World War.

A detailed psychological analysis of patients suffering from such wounds showed that every local lesion of the brain leads initially to the primary disturbance of one particular factor of a given mental activity, and that it is only as a secondary consequence that it impairs the whole complex functional system.

A lesion of the upper areas of the left temporal zone thus gives rise to an impairment of phonemic perception (a complex functional process which develops as language is acquired); a lesion of the secondary and tertiary parts of the lower sincipital and sincipital-occipital area brings about an impairment of simultaneous spatial synthesis; a lesion of the pre-motor zone leads to a degeneration of successive motor synthesis, and so forth.

It was clear that each of these primary disturbances brought about the disintegration of the functional systems which included a particular 'factor' and did not affect systems from which this 'factor' was absent. As analysis showed, the nature of these 'system disturbances' changed in accordance with the location of the affected organ and while any given local lesion of the brain led to the disintegration of a whole range of psychological processes, the nature of the impairment was the same in all cases.

Thus, lesion of the left temporal zone, impairing phonemic differentiation (the evaluation of those sounds in a language which enable the sense of words to be distinguished), inevitably led to a patient's failure to understand speech addressed to him, particular difficulty in finding words to describe objects and an impairment of the ability to write (due to difficulties in analysing the phonetic composition of words) but did not affect space orientation, counting and other forms of activity which did not involve the 'primary' factor referred to. On the other hand, lesions of the lower sincipital or sincipital-occipital zones had the direct effect of impairing spatial synthesis and, as far as the over-all system was concerned, made geometrical orientation impossible and led to difficulties in

counting and failure to understand certain logical and grammatical constructions involving quasi-spatial relations, but could leave such processes as understanding the immediate sense of words, writing, etc., unimpaired.

The discovering of these phenomena, which G. L. Täuber later called the 'double dissociation principle', provided research scientists with new opportunities of analysing the internal structure of the higher mental functions and enabled a direct study to be made of their cerebral organization.

The first step was to analyse the structure of speech processes and carry out a scientific investigation of the various types of speech impairment or aphasia. This led to a fundamental revision of the traditional clinical view of aphasia and the replacement of the description of speech disturbances in terms of external signs ('sensory', 'motor', 'amnesic' aphasia) by a more profound analysis of aphasia in accordance with its internal physiological mechanisms and the 'factors' on which they are based. The results of this research were described in a work of mine entitled *Travmatičeskaja Afazija* (Traumatic Aphasia) which was published in Russian in 1947 and in a completely revised English version in 1970. I have also discussed this question in a number of other publications (1959, 1964, 1967, 1968, 1970, etc.), thereby contributing to the development of a new branch of science, neurolinguistics, a short account of which I have given in my most recently published works (1972).

Neuropsychological research on the impairment of speech processes owing to local lesions of the brain has achieved considerable practical results. It has not only enabled a much more accurate diagnosis of the location of a brain lesion to be made on the basis of a study of the particular features of speech disturbances, but has also provided a scientific basis for the no less important practical question of how to restore speech impaired as a result of local lesions of the brain. I published the results of this aspect of my research in a book entitled *Vosstanovlenie Funkcij Mozga Posle Voennoj Travmy* (The Restoration of Brain Functions after War Wounds) (Moscow, 1948, English edition 1963) and they provided a theoretical basis for the considerable amount of work which I and my colleagues (L. S. Cvetkov *et al.*) have recently been undertaking in this field.

Neuropsychological research on speech is, however, only one aspect of the work in which my colleagues and I have been involved.

The second aspect of this work was a neuropsychological analysis of the structure of conscious, voluntary activity and was linked with the research which has been continuing for many years on the role of the frontal lobes of the brain in the organization of man's active behaviour.

We have already referred to the vital importance in philosophy and psychology of the question of the mechanisms underlying active, voluntary human activity, and to the fact that Soviet psychology has attempted to solve this question by tracing the process of formation of the regulatory function of speech

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in the child. All this research has led us to study the role played by the frontal lobes of the human brain in this process.

Clinical observations have for a long time shown that the frontal lobes, which are the youngest section of the brain and in human beings account for almost one-third of the cerebral hemispheres, are closely linked with the organization of men's voluntary, programmed activity, this activity being determined by complex, conscious motives. Although major lesions of the frontal lobes do not impair sensitivity and movement, and have no effect on the phonetic and grammatical aspects of speech, they do disturb the regulatory function of speech which, as we have seen, becomes apparent in the child at the age of 3–3½ years.

This fact was taken as the basis for a series of observations and experiments which occupied an entire research team, under the guidance of myself and my colleague E. D. Homskaja, for more than twenty years; the results are embodied in a number of publications, including two of my own works—*Vyssie Korkovye Funkcii Celoveka* (Higher Cortical Functions in Man) (Russian edition 1962 and 1969, published in English in 1966, German in 1970, French in 1972); *Mozg Čeloveka i Psihičeskie Processy* (The Human Brain and Mental Processes) (Vol. I, 1963, English edition 1966; Vol. II, 1970)—and a large work published jointly with E. D. Homskaja, *Lobnye Doli i Reguljacija Psihičeskih Processov* (The Frontal Lobes and Regulation of Mental Processes) (1966). I also gave a brief account of them in my lecture to the nineteenth International Congress of Psychology (London) on 'The Origin and Cerebral Organization of Conscious Processes', which has already been mentioned.

The main feature of this research was the discovery that the frontal lobes are an essential mechanism which ensures that the general active state of the brain brought about by a spoken instruction may be altered, and that when the frontal lobes suffer lesions, mental activity cannot be activated in this way by means of speech, see *Mozg i Aktivacija* (The Brain and Activation) by E. D. Homskaja, Moscow, 1972. The second conclusion to be drawn from this research is that major lesions of the brain's frontal lobes considerably reduce the level of organization of purposeful activity and render it impossible for the behaviour of the individual concerned to be made to comply with programmes formulated by means of speech.

The determination of the role of the frontal lobes as a cerebral mechanism responsible for the socially conditioned organization of man's purposeful and active behaviour is one of the important discoveries preparing the way for the solution of one of the major problems of the scientific psychology of human behaviour.

The further analysis of the role of the frontal lobes in complex forms of intellectual activity, described in a book published jointly by my colleague L. S. Cvetkova and myself entitled *Nejropsihologiceskij Analiz Rešenija Zadač*

(A Neuropsychological Analysis of Problem-Solving) (Russian edition 1966, French edition 1967), and more detailed investigation of the role of particular parts of the frontal lobes in the structure of conscious activity, are problems on which I have continued to work in recent years.

I have devoted many years to research on the cerebral mechanisms of speech and conscious activity. A considerable problem persisted, however, which my colleagues and I have investigated only in recent years: that of analysing the cerebral mechanisms of memory and closely related conscious processes.

The investigation of this problem compelled me to move away from an analysis of the functions of external (convex) brain areas to the functions of its internal (medial) areas which are closely associated with the function of the upper parts of the brain stem (midbrain and its connexions). Observations carried out over a number of years have shown that lesions of external (convex) brain areas may lead to the impairment of particular cognitive forms of activity, speech and the structure of human activities, but never give rise to disturbances of over-all memory, space orientation and consciousness. However, such disturbances may easily result from lesions of the internal (medial) areas of the brain or the limbic area and their connexions with the upper parts of the brain stem.

These facts are understandable in the light of recent research on the precise morphology of the brain which has shown the specific role of the neurons of the hippocampus and the caudate nucleus in distinguishing particular signals from the traces of previous stimuli, and in view of physiological research on the role of the reticular formation, and they induced my colleagues and myself to begin a new series of investigations which are summarized in my most recent books: *Rasstrojstva Pamjati v Klinike Anevrizma Perednej Soedinitel'noj Arterii* (Disturbances of the Memory in the Clinical Treatment of Aneurism of the Front Connective Artery) (1970), written jointly with A. N. Konovalov and A. Ja. Podgornaja, and *Nejropsihologija Pamjati* (Neuropsychology of Memory) (1973).

The results of this research have shown that man's mnesic activity (memory) is intimately linked with the areas of the brain just referred to and that a lesion in these areas brings about a general memory impairment, rather than partial impairment of any one mnesic faculty (auditory, visual, motor); they also show that the main physiological mechanism of such lesions is increased inhibition of impulses by extraneous (interference) stimuli.

This experimental research conducted by myself and fellow scientists (N. K. Kijaščenko *et al.*) has provided new methods for analysing the structure of the memory disturbance associated with pathological brain conditions and distinguishing the various ways in which the retention and recollection of information are impeded in cases where an active recollection of the past is seriously impaired and when various physiological mechanisms play a part in this impair-

ment: increased inhibition of impulses by interference stimuli, pathological inertia of impulses once they have occured with the result that they inhibit the activation of previous impulses, and so forth.

My colleagues and I are continuing this research which, it is hoped, will open up new prospects in the study of the psychological structure of the cerebral mechanisms of consciousness and in the development of a new branch of science —'neurolinguistics'—to which I have already referred and an extremely important aspect of which is the analysis of the various types of disturbances that impair the retention of particular elements of spoken information.

The latter problem is the subject of my book *Osnovnye Problemy Nejrolingvistiki* (Fundamental Problems of Neurolinguistics) now being prepared for publication, and of current research to which I do not yet think it advisable to refer in detail.

The problems referred to mark the end of the series of projects representing my contribution to the development of neuropsychology.

The major publications summarizing my results in this field have already been mentioned and are *Higher Cortical Functions in Man* and *Osnovj Nejropsihologii* (English edition entitled *The Working Brain*) which has just been published. These works are among those which have firmly established neuropsychology in the theory and practice of contemporary teaching on human brain functions and they represent an attempt to bring together the social and natural sciences and to show the social nature of brain functions in man, which I consider to be one of the most important aspects of this branch of science.

This account of my scientific progress here would be incomplete if I failed to refer, at least very briefly, to the most recent aspect of my work, which is totally unrelated to neuropsychology but which may develop into an extremely important project falling wholly within the province of the social sciences.

Even before the death of L. S. Vygotskij, scientific psychology faced a problem, the vital importance of which could scarcely be exaggerated. It was necessary to make a fundamental reappraisal of the main tenets of psychology and to show that its basic concepts are not immutable features of the natural or intellectual universe but change as society develops and are socio-historical in character.

This problem, which had already been raised by L. S. Vygotskij, merits special attention.

For centuries it was tacitly accepted that the main psychological processes—perception and memory, association and ratiocination—were universal categories, inherent in either the spiritual or the natural order, but in any event independent of social history.

Is this correct? Are not the fundamental mental categories that have evolved historically processes in the same way as all the other processes of social history? Should we not suppose, in accordance with the postulate of Marx,

Real logical categories depend on the specific forms of man's social activity and the basic patterns of human thought alter in accordance with changes in the basic forms of this activity

that 'there is only one science, the science of history', that in the successive stages of a society's development, not only the content but also the form of cognitive processes changes and that the very logic of human thought is the product of social and historical development?

At the beginning of the 1930s, when these questions were first raised in Soviet psychology, science had witnessed only one attempt to cast doubt on the universal nature of logical categories and this had been made by the French sociologist Lévy-Bruhl who tended to think that thought develops not from specific experience (in particular, experience of creative work) but from the magical (mystical) relation of man to reality.

This attempt was naturally considered by Soviet psychologists at that time to be as unconvincing as the belief in the universality and immutability of all mental categories.

Accordingly, L. S. Vygotskij and I decided as early as the very beginning of the 1930s that we would attempt to demonstrate by scientific observation that both concepts were erroneous and to substantiate the view that real logical categories depend on the specific forms of man's social activity and that the basic patterns of human thought alter in accordance with changes in the basic forms of this activity.

The period during which our psychological observations were made was ideally suited to this problem. A radical reorganization of the fundamental economic structures of the outlying areas of the Soviet Union was taking place, involving the transition from a system of subsistence farming to more complex economic practices and gradual collectivization. In regard to culture, this period saw the elimination of illiteracy, which brought about a real cultural revolution.

All this encouraged us to undertake an experiment in social psychology aimed at studying the changes in fundamental logical operations that were taking place against the background of these social developments and discovering the relation of the real forms of human thought to specific historical conditions.

Such an attempt was made by myself and my colleagues in 1930/31—forty years ago—in the course of a special expedition to the outlying areas of Central Asia; owing to circumstances outside my control and relating, in particular to my main field of research—neuropsychology—the results of this research were only drawn up forty years later and the first data were not published until 1971, in a collection of articles entitled *Istorija i Psihologija* (History and Psychology) and in the *International Journal of Psychology*; the main book summarizing these data, *Ob Istoričeskom Formirovanii Poznavatel'nyh Processov* (On the Historical Formation of Cognitive Processes), is only now being prepared for publication.

The work carried out by myself and a large number of colleagues included more than thirty experimental research projects and its main aim was to show how fundamental cognitive operations in fact take place under various historical

conditions and at various stages of social and cultural development. It therefore took the form of a comparative analysis of inhabitants of distant areas leading a secluded agricultural type of life, individuals who were already engaged in collective farming and were not totally illiterate, and individuals with a relatively extensive experience of active community life and a certain amount of education. They all belonged to the same ethnic group but the level of their community life and education varied.

This research began with an analysis of extremely simple generalization operations (classification of objects and their inclusion in a single general category); a thorough investigation of logical deduction and reasoning operations and a study of the structure of perceptive activity and modes of memory were then carried out and, finally, a study was made of the powers of imagination and conscious self-analysis.

This enabled phenomena to be described which, even in the light of comparative research ('cross-cultural studies') undertaken on a large scale only much later, are of undoubted value.

As we have already pointed out, it is generally held in psychology that the process of generalization or classification of objects into simple general categories reflects the universal characteristics of logical thought and conforms to the same laws in the case of every adult. It seemed reasonable to suppose that if an adult was asked to single out from four pictures representing a saw, an axe, a spade and a log, three which belong to a single category and which can be referred to by a single term, the first three would be classified as 'tools' and the last, representing a 'material', would be viewed as the exception.

This operation was carried out with ease by those subjects who were most culturally developed but could not be done by the group of individuals who lived under the most backward economic conditions and had remained illiterate. They grouped together 'log, saw and axe' as these were used in the same practical situation ('a log must be cut with a saw and chopped up with an axe') and excluded the spade 'the spade is used for a completely different purpose, it is not required here'. A practical operation—identification with a common action situation—here replaced the theoretical operation: classification under a general abstract category.

This basic phenomenon had a decisive effect on all the other cognitive operations. This group of subjects had difficulty in making a logical deduction from a given premise: if the premise related to their practical experience, the deduction was made without any difficulty, although more often by reconstructing the visual situation than by discursive reasoning; if the premise was unrelated to their practical experience, they refused to make any logical deductions whatsoever and said: 'I have never met this, I am not qualified to talk about it, ask people who are acquainted with it'. More complex discursive operations were tackled in the same way and this provided a convincing demonstration of the fact that the fundamental structure of thought in these individuals was

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determined by laws of specific practical experience and not by laws governing abstract logical operations.

When we turned to the study of the second group—people from the same background but who had learned to read, taken six-month short courses and embarked on life in a collective setting, where each step is planned on the basis of joint discussion—the picture changed radically and all the operations which had appeared senseless and therefore beyond the grasp of the individuals in the first group could now be carried out without any difficulty. Similar results were obtained from our research on perception and imagination, which at the initial stages related to specific practical experience and only later moved beyond the limits of that experience, and from our analysis of the evolution of individual self-awareness, power of self-criticism and so forth.

Although it is difficult to present the results of this research in a very concise form, it did demonstrate a fundamental point: the psychological laws governing cognitive processes are not universal and unchanging; not only the content but also the forms of cognitive activity are the product of social and historical development, the whole course of which dictates that at the initial stages these forms fall within the limits of specific practical experience (and represent the laws of practical thought) and subsequently move beyond these limits and gradually develop to form the processes of theoretical thought, which has its own rules and develops in accordance with its own laws.

Even the processes of self-realization, which for Descartes formed the basis of all mental activity, are in fact the product of social and historical development and should be regarded not as the beginning but rather as the end of a complex social and historical process.

The analysis of the historical formation of fundamental psychological categories appears to us to be one of the basic principles of psychology and it is to be hoped that a reappraisal of psychology from this standpoint and the establishment of psychology as an historical science will be one of the main features of its further development.

We have given a brief survey of the long road that has been covered and experience a feeling that will be readily recognizable to everyone who tries to look at the past in order to obtain a better understanding of prospects for the future.

Many vital questions have been raised in psychology over the last fifty years and it has been realized that many of the branches of psychology call for radical reorganization. But to realize this is merely to understand how very little has so far been achieved and to comprehend the vastness of the unknown territory that lies ahead.

[*Translated from Russian*]

Selected bibliography

Reč' i intellekt v razvitii rebenka. Moscow, Academy of Pedagogical Sciences, 1927.

Etjudy po istorii povedenija (with L. S. Vygotskij). Moscow, OGIZ, 1930.

The nature of human conflicts. N.Y. Liveright, 1932.

Eksperimental'noe razvitie konstruktivnoj dejatel' nosti. Differencial'noe obučenie odnojajcovyh bliznecov. Moscow, Moscow Genetics Institute, 1936.

Traumatic aphasia. The Hague, Mouton, 1970.

Vosstanovlenie funkcij mozga posle voennoj travmy. U.S.S.R. Academy of Medical Sciences, 1948. (Also in English: *Restoration of functions after brain trauma.* Oxford, Pergamon Press, 1969.)

Očerki psihofiziologii pis'ma. Moscow, Acad. of Ped. Sciences, 1950.

Rol' slova v formirovanii vremennyh svjazej v normal'nom i anomal'nom razvitii. Moscow, Acad. of Ped. Sciences, 1955.

Rec'i razvitie psihičeskich processov rebenka (with F. Ja. Judovic). Moscow, Acad. of Ped. Sciences, 1956. (Also in English: *Speech and the development of mental processes in the child.* London, Staples Press, 1961; Penguin Education, 1971.)

Brain disorders and language analysis. *Language and speech,* vol. 1, 1958.

The role of speech in the regulation of normal and abnormal behaviour. Oxford, Pergamon Press, 1959.

Vyssie korkovye funkcii čeloveka i ih narušenie pri lokal'nyh poraženiah mozga. Moscow, Moscow University Press; 1st ed., 1962, rev. ed., 1969. (Also in English: *Higher cortical functions in man,* New York, N.Y., Basic Books, 1966; in Italian, Milan, 1967; in German, Berlin, 1970.)

Mozg čeloveka i psihiceskie processy. Vol. I, Acad. of Ped. Sciences, 1963; Vol. II, Moscow, 'Pedagogika', 1970. (Also in English: *Human brain and psychological processes.* New York, N.Y., Harper & Row, 1966.)

Lobnye doli i reguljacija psihologičeskih processov (with E. D. Homskaja). Moscow, Moscow University Press, 1966.

Nejropsihologičeskij analiz rešenija zadač (with L. S. Cvetkova). Moscow, 'Prosveščenie', 1966. (Also in French: *Troubles de solution des problèmes au cours des lésions du lobe frontal,* Paris, Gautier-Villars, 1967.)

Malen'kaja knižka o bol'soj pamjati. Moscow, Moscow University Press, 1968. (Also in English: *The mind of a mnemonist,* New York, N.Y., Basic Books, 1969; in French: *La mémoire prodigieuse,* Paris, Delachaux & Neistle, 1970; in Polish: *Pamiat która ne imela granic,* Warsaw, 1969.)

Poterjannyj i vozraščennyj mir. Moscow, Moscow University Press, 1970. (Also in English: *The man with a shattered world,* New York, N.Y., Basic Books, 1972.)

Ob'ektivnoe issledovanie dinamiki semantičeskih svjazej (with O. S. Vinogradova). Moscow, Nauka, 1971. (Coll. Semantičeskaja struktura slova.)

Basic problems of neurolinguistics. In: *Modern traits in linguistics,* vol. 12 (forthcoming).

The working brain. Penguin Education (forthcoming).

Nejropsihologija pamjati. Moscow, 'Pedagogika' (forthcoming).

Psychological studies in local brain lesions. Oxford, Pergamon Press (forthcoming).

Behavioral physiology of the frontal lobes (with R. H. Pribram, ed.). New York, N.Y., Academic Press (forthcoming).