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Neuropsychology as a Science.

—

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During the last period a new branch of psychology has developed, - and that is Neuropsychology.
This branch is of a high importance both for the practi applic problems of Neurological Medicine and for the General Psychology.
It happened that I was a witness as well as a direct participant of the formation of this branch; that is why I have chosen for this Evening lecture the topic of "Neuropsychology as a science".

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1.

Neuropsychology is emerged as a result of practical demands of the modern Neurology and Neurosurgery.
I still remember a time - some fourty years ago - when brain tu and massive brain hemorrhages were supposed to be incurable and when the diagnosis of a brain tumor - malignant or benign - was equal to a death sentence.
During the last few decades the situation has changed. Brain tumors as well as intracranial hemorrhages have become an obj of surgical treatment; new methods of prevention of bleeding and brain swelling made it possible to remove pathological foci from brain tissue and to preserve the life of the patients for a long tim That is why the basic problem of an early and precise diagnostics of the location of the brain injury, as well as the problem of the scientific bases of the rehabilitation of patients after brain injur became now most important.
We shall try to show, what can scientific psychology do to so these problems, and first of all - how psychological methods can provide an early and reliable local diagnostics of brain injury. The solution of this problem is the first practical task of Neuropsychology.

A precise diagnostics of the site of a tumor or hemorrhage is no at all an easy task. It is well known that the clinical methods of topical diagnostics of a lesion are very limited.
After a century of experience Neurologists have developed a battery of Neurological tests which are valid and reliable for a local diagnos of some brain injuries; ~~but these tests are restricted to evaluate distur~~ such symptoms as loss of sensitivity, restriction of movements alteration of the tone of the muscles and of reflexes, partial distur

of visual fields, - are of a high value for a precise diagnostic of the location of brain injuries.

But these symptoms have a limited value. It is well known that at least three quarters of the territory of the brain hemispheres have nothing to do with sensitivity or motricity, tonus or reflexes; the predominant part of human cortex can be considered as an apparatus of higher behavioral processes of elaboration and storage of the information, of programming and control of human actions. It is evident that lesions of these zones don't result in disturbances of simple sensation, movement and reflexes, and that a careful analysis of complex changes in behavior has to be used for the diagnostics of lesions of these complex parts of the brain.

Now we come to the basic problem: it is well known that such behavioral processes as elaboration and storage of information or control of action are processes of a high complexity, and that they can suffer in lesions of very different, widespreaded zones of the brain. Does it mean that a careful study of behavioral changes in local brain lesions cannot be used for a precise topical diagnostics of the location of the lesion?

Modern psychological approach to the structure of psychological processes, as well as modern knowledge of the basic functional organization of the brain can be of a considerable help in our attempts to find a scientific answer to this question.

Let us examine both problems very shortly.

Primitive concept of psychological functions as simple inborn faculties based on separate circumscribed centra of the brain cortex - which remained in psychology during centuries - is now totally abandoned. After a series of important discoveries, a series of outstanding scholars [P. Anokhin and N. Bernstein in the USSR, K. Pribram and others in USA] it became clear that behavioral processes are to be considered as complicated self regulating systems which start with a basic goal, are based on a plan or program and are realized in a series of operations, leading to an ultimate effect; it became clear that the effect of every action is signalized in the brain, and if the matching of the result of the action with the initial plan shows the action succeeded - the behavioral activity stops; if such concordance is absent - the action continues.

Such self-regulating structure of every psychological process is differently formulated by different scholars and it is well known as the process of T-O-T-E of Prigram, Miller and Galanter, as the mechanism of the „Acceptor of Action" of Anokhin or the process of matching of „Ist-Wert" and „Soll-Wert" of N. Bernstein. This scheme is equally acceptable for such elementary such biological systems as breathing or waking as for complicated behaviour systems as writing or reading, problem solving and decision making; the only difference is that complicated psychological systems are social or historically by their origin, indirect, using tool or symbols by their structure and conscious or voluntary by their mode of functioning.

Now we come to the basic question: what is the cortical organization of these complex and self-regulating functional systems?

It is obvious that they cannot be „located" in circumscribed groups of nervous cells and that no isolated „centra" for complex functional systems can exist. But after all we know from the modern Neurology it is equally obvious that the complex behavioral processes are in no case functions of equipotential parts of the brain tissue and that different parts of the brain don't play the same role in their organization.

All we know from modern Neurology leads us to a conclusion that complex behavioral processes are results of a co-ordinated work of dynamic systems of different parts of the brain, and that every part of the brain plays its own, highly specific role in the organization of psychological processes.

That is why complex behavioral processes can suffer in cases of different lesions of the brain; but lesions of different parts of the brain result in disturbance of very different, specific factors and are associated with very different type of disturbance of the same functional system.

That is why a careful neuropsychological analysis of behavioral changes in cases of differently located lesions of the brain can be applied for a topical diagnostics of local brain lesion.

And that makes Neuropsychology a valuable method

~~most important problems of Neurological clinic - in localizing lesions of~~ that of an early and precise local diagnostics of the lesions of the Brain.

2.

Let us ~~now~~ summarize the basic principles of the functional organization of the Human Brain; a clear understanding of these principles ~~can~~ is of a ~~principal~~ basic significance for Neuropsychology.

Modern Neurological Science ~~gives all grounds for a statement~~ can single out, ~~that the Human Brain consists of~~ at least three basic blocks; which are the basic functional parts of the brain; all these blocks participate in every behavioral process, each of them making its own contribution to the ~~flow~~ construction of psychological processes. That is why a disturbance of ~~even~~ each block results in a ~~defect~~ disorganization of ~~the~~ complex forms of human behavior, but the type of ~~this~~ disorganisation is different in lesions of different blocks. ~~(After the brilliant investigation of Magoun and Moruzzi, Jasper and Lindsley)~~

The first block can be designated as the block of energy and tone of cortical processes. After the brilliant investigation of Magoun and Moruzzi, Jasper and Lindsley it is ~~clear~~ evident that this functional unit includes the apparatuses of the lower and higher brain stem and the reticular formation. These parts of the brain stem are in close double-way ~~connection~~ relations with the cortex, especially with the mesio-basal parts of the frontal lobes; they provide a stable optimal tone of the cortex which is one of the most important conditions for a normal ~~selective~~ organization of psychological processes, a selective organization of the input ~~of~~ and storage of information, for a stable preservation of the programs and plans of behavior, for a precise evaluation of the outcome of actions.

If the first block is injured, and a tumor or ~~hemorrhage~~ cerebral hemorrhage disturbs the higher parts of the brain stem, the walls of the third ventricle or the limbic parts of the brain ~~are disturbed~~, - the whole cortex ~~comes~~ enters in a pathological state: the tone of the cortex ~~(is lowered, the stability of the neurodynamic processes becomes deranged, and the selectivity of psychological processes)~~, the stability of normal neurodynamic processes becomes disturbed, ~~and~~ marked deterioration of wakefulness, ~~retention and~~ disorganization of memory traces is seen, and the selectivity of

the psychological processes ~~can~~ suffers.

You may know the general law of neurodynamics described by Pavlov as „the law of force": In a normal cortex strong or significant stimuli become dominant and evoke strong reactions while feable or unsignificant stimuli ~~can easily suppress~~ evoke unstable traces and can be easily suppressed. That provides a selective concentration of excitatory processes and that is one of the most important conditions for the highly ~~organized~~ and selective organization of all mental processes.

The situation changes when the tone of the cortex is lowered, and Pavlov's ~~ob~~ observations described the „inhibitory states" of the weak cortex: now strong or significant stimuli evoke the same responces as the weak or unsignificant ones, a concentration of excitatory processes on dominant foci becomes impossible, and when the inhibitory states increases, - ~~weak or unsignificant~~ the ~~cortex~~ of the cortical processes ~~is~~ a paradoxical state, is seen and weak or insignificant stimuli begin to evoke even stronger reactions that strong and significant one.

~~One~~ You can imagine what a disorganization of a normal flow of psychological processes ~~results from these lesions~~ is associated with such states; remember how diffuse ~~became our thoughts and~~ and disorganized became our thoughts in a drowsy state and how strange are our association in ~~hypnagogic~~ situations of fatigue and dream... It is obvious that a lesion of the ~~parts of the first block~~ higher parts of the brain stem, tumors of the third ventricle or parts of the limbic system ~~result~~ inevitably result in marked changes of behavior: mental processes become ~~exhaustable and instable~~ exhaustable and instable; memory traces ~~are~~ turn to be weak and are easy inhibited by ~~inter~~ every interference; the flow of association loses its normal selectivity and the control of behavior suffers. ~~Dr~~ ~~Fu~~ A year ago ~~we~~ I described jointly with my friend ~~Mc~~/Macdonald Critchley ~~such~~ some behavioral results of a tumor of the mesial parts of the frontal lobe, and since that publication new data on the ~~to~~ disturbance of stability of behavioral processes in lesions of the deep parts of the brain are collected.

The second block of the brain is much better studied and its role in the functional organization of behavior is much better known.

It includes the posterior parts of the cortex and plays a dec
role in the input, coding and storage of information. Its funct
nal organization is highly different from the first block: whi
The neuronal nervous apparatus of the first block are to a consid
rable degree unspecific and provide a gradual change of wakeful
ness, - the neuronal systems of the second block have are highly mo
dality specific, and we can easily distinguish separate pa
of the cortex which have a role of optic, acoustic, or Kinesth
of cutaneous or Kinesthetic analyzers. In contradistinction t
the apparatuses of the first block, - every part of the second
block has a very precise hierarchical organization: it has
a base a circumscribed primary (or extrinsic) cortic
zones - zones of the input of visual, acoust
or sensory information; these zones are organized by correspo
secondary (or intrinsic) zones which plays a decisive role in funct
organization and coding of information; the hierarchical organi
zation is completed in tertiary zones which can be designed as zo
of overlapping of different specific parts of the cortex and which ser
as special devices of simultaneous (or quasi-spatial) synth
of separate data and which are necessary for the organization of
tial) schemes of behavior.

The principles of the functional organization of these zones
well known, and the latest findings of the function of single neu
with the highest specificity of their work, described by Hubel
and Wiesel, Jung and others open new vistas in the analysis of
their intimate mechanisms.

It is clear that injuries to the different parts of this secon
block of the brain result in behavioral disturbances which a
very different from these of resulting from lesions of the first
lesions of primary zones of (visual, acoustic or sensory) zones o
this block
the cortex result in very specific visual, acoustic or sensory defici
yet and don't bring marked behavioral changes. Lesions of the se
dary zones are associated with more complicated, but highly sp
as a rule
disturbances which are restricted to specific modalities
Such well known facts as optico-agnostic or acoustico-gnostic defects or dis
turbances of elaborated decoding of phonemes can serve as ex
of such serious functional disorders. It has to be stressed that
lesions of secondary zones of each part of the second block occip
or temporal zone of the cortex inevitable are inevitable associate
with not only with very specific processes of coding of informatio

of a certain modality
(but has as a result a disorganization of all complicated ~~functional~~ behavioral processes which include the disturbed link and which cannot remain ~~be~~ normal when the coding of corresponding informa-tion is disturbed, while all behavioral processes which don't inclu the ~~disturbed or~~ damaged link remain undisturbed. We shall see further what a great importance has ~~has~~ this fact for Neuropsychologica diagnostics of local brain injuries.

Perhaps of the ~~mo~~ special importance for neuropsychology are the resu of lesions of the most complex - tertiary zones of this block.

Neurologist know all right that ~~the disturbances~~ lesions of the „zo of overlapping" - and first of all of the ~~Tem~~ infro-parietal (or temporo-parieto-occipital) parts of the cortex doesnot only result a deterioration of such processes as visual orientation in space, but play a decisive role in disorganization of complex symbolic processes. Such lesions ~~lead~~ inevitably result in a disturbance of the „synthe of separate traces in coherent wholes", and one of the most importa findings of Neuropsychology is the disorganization of complex logico-grammatical, ~~and num~~ semantic and numerical operatio which have a quasi-spatial ground ~~and which~~ become imposs after lesions of ~~tertiary~~ parieto-occipital parts of the left hem spere. We have ~~an~~ analyzed these disturbances in special books and shall not dwell on ~~these dis~~ them further.

We have spent a considerable time studying the role of the Th block in organization of behavioral processes. It includes the anteria parts of the brain and is intimately involved in organization of intentions, ~~prog~~ and plans, ~~of behavior in~~ in programming, regulation and cont of behavior. A ~~series~~ group of outstanding scholars - Bianchi ~~and~~, K. Prib and Konorski ~~and Rosvold~~ in animal studies, Bekhterev and Kleist, and Denny B ~~Broca Brown and several N logists and Neuropsychologists~~ in clinical ~~studies~~ observations have ~~contributed~~ important contributions to our knowledge about the functions of frontal lobes, and I can only summarize ~~here~~ our findings.

It is well known that the Frontal Lobes - the latest and most com part of the human hemispheres have neither sensory or motor func and that severe lesions of the Frontal Lobes are not associated with defects of sensations, movements, ~~or~~ gnostic and praxic processes or s Nevertheless ~~the~~ human Frontal Lobes in no case can be considered «mute zones» of the cortex, and a series of latest findings made it

how important is their participation in every complex behavioral processes.

Frontal lobes of the human brain and first of all their mesial and basal parts have very intimate ascending and descending connections with the brain stem and its reticular formation, and that makes Frontal Lobes an important device for regulation of active states of human behavior.

Only a few years ago Grey Walter showed that each active expectancy evokes special slow waves in the frontal cortex, and that "expectancy waves" disappear after the subject's attention is exhausted. Simultaneously M. Livanov from Moscow showed that each intellectual strain results in an emergence of a complex synchronous excited points in the frontal cortex and that these Synchronously working foci disappear in a passive state or after application of tranquilizers.

These data made it highly probable that Human Frontal Lobes play a decisive role in the process of activation.

This assumption was confirmed by observations of my friend Dr E.D. Khomskaya and her co-workers made in our laboratory. A series of experiments proved that in a normal person a verbal instruction which added a special signalling function to a stimulus ("pay attention!", "count the stimuli!", "press the key after the stimulus appear!") result in a marked vegetative and electrophysiological changes which can be regarded as symptoms of an orienting reflex (constriction of vessels, degression of alpha-rhythm, change of frequencies of the EEG and in the asymmetry of ascending and descending fronts of the alpha waves, intensification of evoked potentials). All these changes can be observed as well in patients with lesions of the posterior parts of the brain; but they disappear in patients with severe lesions of the Frontal Lobes and especially of their mesial parts.

That proves that the Frontal Lobes play an important role in regulation of active states of the brain, and that lesions of the Frontal Lobes result in an inability to preserve vigilance which is basically important for all stable decisions, preservation of plans and active regulation of behavior.

Such role of the Frontal Lobes in the process of activation explains a series of behavioral changes observed in patients with severe lesions of the Frontal Lobes.

Psychiatrists know all right that patients with tumors or wounds

of the Frontal Lobes become inactive, lose they future-directed beha
~~or~~ and ~~become they~~ are unable to evaluate the effects of their ac
They lose the ability to construct intentions and to follow the pr
grams given by verbal instructions; although they retain the inst
tions, they become unable to follow them and their meaningful,
selective behavior ~~is becon~~ is easily replaced by impulsive „fie
linked" actions or passive stereotypes.

If the patient is asked to make a simple ~~echopractic~~ reaction,
imitating the movement of the experimenter, he does it all right; bu
if the instruction requires a re-coding of the stimulus given and
the movement has to follow an intermediate program ~~for example~~
(such is the case when the instruction is given: „When I lift my fi
- you will show me your fist; and when I lift my fist - you will show
me your finger) - the required action ~~is~~ becomes very soon ~~rapidly~~ rep
aced by primitive, imitative reactions. The same can be seen if the pa
tient has ~~to fulfill~~ give a reaction of choice, lifting his right hand after
a single knock, and his left hand after a double knock. It is eno
to repeat this action two-three times and then to change the sequen
of signals, - and the patient ceases to give adequate choice reac
tion and replaces them by senseless stereotyped movements (R-L
R-L-R-L) independent from the signals.

Such loss of the selective, ~~meani~~ programmed forms of behavior c
be seen in more complex experiments where ~~selection intentions~~ dom
(X) nant intentions are replaced by unselectively evoked associations
or inert stereotypes.

If the patient with severe lesion of the Frontal lobe is unable to fol
ready-made programs ~~to~~ given in the instruction, it is evident that he
becomes totally unable to build his own plans, to select useful in
formation and to ~~single out~~ construct a strategy of a complex
behavior.

We can show that by two experiments.

It is well known that if an instruction is given to a normal person
touch with closed eyes ~~to~~ a sets of checkers, one in a form of „H" and
the second in a form of „E" and to decide which of both letters is give
the subject begins with extended trials but very rapidly replaces them
trials by abbreviated process, singling out the useful information a
touching only the ~~places~~ checkers which made the difference of the
two letters. That is not the case in Frontal Lobe patients. NO seeking movements and n
viation of the process takes place, and no attempts to single out usef
(XX) information is observed; the patient continues to touch all checkers
but is unable to receive the information needed and to make ~~a~~ the
decision required.

The same can be seen in an even more impressive experiment.
It is well known that ~~per virtual~~ evaluation of a complex ~~picto~~ visual information requires a strategy of perception, and that ~~the~~ eye movements ~~are can be~~ of the subject ~~can~~ very reflect such a strategy. It is very easy to show that recording ocular movements of a normal person during observation of simple and complicated pictures, ~~w~~ ~~the me~~ fastening a mirror to the sclera and recording the beam of light reflected during this observation (a method proposed by A.L. Yarbu
The records obtained show that a normal person singles out the most ⊗⊗ informative points of the picture, and when different instructions were given, - the strategy of eye movement changes entirely.
No such process is seen in patients ~~e~~ with lesions of the frontal lobes, and searching, meaningful movements are replaced here by ~~(not stere chaotic a)~~ senseless, chaotic or inert stereotyped ⊗ eye movements showing that the strategy of ~~searching action~~ selec searching actions becomes impossible.
I shall spare your time and shall not dwell on the analysis of the destruction of problem solving behavior in these patients; it is de scribed in one of my latest books published with ~~d~~ L.S. Tsvetkova where the full information can be obtained.

We can stop our analysis of the basic functional blocks of the hu man brain and their role in the organization of behavioral pro cesses.
It is easily seen that each block takes part in ~~the~~ the organizati of complex ~~behavior~~ behavioral processes, playing providing its own role in this organizati That is why a careful neuropsychological study of the type of b behavioral changes after local brain lesions can be of a high value for a local diagnostics of ~~the~~ brain injuries.

3.

We have summarized our ~~modern~~ knowledge about the basic bloc of the human brain. = Now we ~~x~~ can return to our initial questi Can Psychology be of any help in the local diagnostics of brain injuries?
It is clear now that no complicated psychological process is locali in a definite circumscribed cortical area and that ~~it is as a re result~~ every form of complex behavior is a result of a joint work of a functional system of different zones of the brain, ea of them providing its own component to the physiological bases of

behavioral processes.

That ~~means~~ has a decisive significance for the evaluation of behavioral symptoms of every local brain injury. It means that disturbances of every complex behavioral process can be ~~se~~ from differently located brain lesions, but each time the pathological focus eliminates one or another specific factor, ~~the~~ participating in a functional system, and the structure of behavioral disturbance is ~~very~~ different.

Let us show that using only one example; but this example will convince us how important is a sophisticated psychological analysis of the type of dissolution of behavioral processes in case of differently localized brain injuries.

By didactic purposes we shall choose the example of disturbances of writing in different local lesions of the brain. ~~Each~~ That example can ~~give us~~ make it possible to show the type of ~~his~~ Neuropsychological analysis of a very complicated disturbance ~~and as well as~~ and serve us as an ~~example~~ model of a ~~process~~ ~~evaluation of its injury~~ psychological evaluation of the local brain injury.

The idea that disturbances of writing ~~are~~ is a result of a very circumscribed lesion of the middle parts of the premotor zone of the left hemisphere - the ~~the~~ "Exner's centre" is abandonned more that a half century ago. During the first decades of this century it became clear that writing is not at all a complex system of hand movement, ~~and~~ that its structure is much more complicated, and that practically defects in writing can be observed in ~~a very broad~~ cortical ~~area~~ lesions of a very broad area of the left hemisphere. But neuropsychological observations have shown that the kind of writing disturbances is very different in lesions of different parts ~~of the~~ zones of the human cortex.

Let us ~~firstly analyse the psy~~ start from a psychological analysis of the process of writing, and try to explain how this process can suffer in different lesions of the brain.

To write down a word we have ~~to single out~~ listen to the continuous flow of speech sounds and to single out separate, discrete ~~sounds~~ phonemes which we ~~se~~ have to code in letters. This is a complex ~~problem~~ process, and

a good.
~~an acute hearing~~ ear is not at all sufficient for such an
is. Every language has its own phonemic system; it means th
every language uses its own acoustic cues which play a decisi
role in discrimination of one meaning from another. Sometime
These cues are very fine, but for a person who is grown
up in a culture of this language they are decisive and very easy
distinguishable: for an Englishman „vine" and „wine", „special
and „spatial" sound very differently and he can hardly make
a mistake in their discrimination; so are the sounds „b" and „p
both in English and in Russian, and „bull" and „pull", „b
and „park" are very different words which hardly have so
features in common although their acoustic difference is a very sig
one.

The situation changes if we turn to phonemic systems which are
different from our native language. The case of „softness" (Russian "hardness" and
strange for the English or French language, and that is why three
words totally different for a Russian (пыл = fire, мыл =
= dust, and мул = he donkey) are hardly distinguishable for an
English - or French speaking subject. The same happens is typical
for the chinese language, where the light of the pitch is a
decisive cue, and where „ma" means „to buy" and „ma" mean
„to sell", or for one of the caucasian languages where
„antlico" means „six", and „antlico" - means „seven." I can
only mention as well as for that Vietnamese language where „tü" pronounced wi
different pitches has at least six meanings!

But the differentiation of phonemes is a task fulfilled with the par
cipation of the cortical parts of the „acoustic analyser" - and pa
especially of the secondary zones of the left temporal lobe,
which have intimate connections with other parts of the „speech area
that is why a lesions of this zone result in a disturbances of the
discrimination of close (or correlative) phonemes, and patients
with wounds of that region become unable to discriminate such
sounds as „b" and „p", „t" and „d" (evaluating them as even in their own language
unsignificant variations of the same phoneme. Our observations
on many hundreds of patients with local brain wounds and
tumors made this discrimination of phonemes one of the most reliable
tests of lesions of the left temporal lobe.
This basic defect has marked secondary results, and one of them

is a severe disturbance of the writing in patients with lesio of the left temporal zone. Of an importance is the fact that th disturbances ~~are have a~~ are of a very distinct type: pa ents with lesions of the left temporal lobe confuse „o in their writing „correlative phonemes", can write „tome" instead of „d ⊗ or „pull" instead of „bull"; they hardly can single out se parate phonemes from complex groups of consonants, and their writing becomes highly disturbed.

It is very interesting to note that severe disturbances ~~in~~ of writing in patients with lesions of the acoustic regions of the dominant hemisphere which are one of the basic symptoms of such lesions in europians, are not seen in chinese because their writing is an ideographic one and is not based on discrimination of different phonemes!

Acoustic analysis of phonemes is the first step of writing but not at all the only one.

~~The it~~ To improve the ~~phonemic~~ analysis of the phonemes one has ~~to~~ sometimes to apply additional aids, and these aids are the articulation of a sound, the motor analysis of its structure of the word. „How do you spell your name?" one asks when the ~~sound~~ phonemic structure of the name remains uncertain ~~(unclear)~~: „B-a-m-b-l-e?.." And when we add an articulatory analysis of the world - its structure becomes certain ~~clear~~, and we are able to write (dow

To prove the role of the articulation in writing I asked one of my co-workers to make a special observation in a class of pupils. If you enter a class of a first or second grade pupils studying writing ~~in Russian or German schools (it is not the case of English schools)~~ - you can mark a noise in the class: pupils try to pronounce the words they write, and the class is full with a buzz. Is that useful or distractive? Teachers hardly can answer this question.

To prove that I asked my co-worker to compare ~~record~~ writing associated with such ~~acti~~ aloud repetition of the words with ~~and w~~ the same process in different conditions, when ~~I a~~ we asked the children to write holding their mouth open or squeezing their tongue between their teeth. In the last cases the amount of mistakes in writing increased six times!

That means that at the first stages loud articulation of the word is

of a considerable help for evaluating the sounds and for wr
and that only at the latest stages this component becomes
less significant.

But a precise articulation requires a participation of
different cortical zones, - and first of all a participation of
the post-central (kinesthetic) parts of the cortex of the left
hemisphere. That is why in lesions of these parts we observe
disturbances of precise articulations, confusion of similar (or
correlative) articulemes (as „b" - „p", or „d", „t" and „n")
and new difficulties in writing, - this time in form of confusing (letters) of writing which are differently articulated.
In such cases the patient can write „ston" (groan) instead of „sto
(table), „Khenat" or „Khadat" (meaningless) instead of
„Khalat" (coat), - and for a trained Neuropsychologist
such mistakes give a ground to suppose lesion of post central
parts of the dominant hemispheres as a cause of the writing
disturbances.

The process of writing begins with the evaluation of phonem
but has to go several steps further.

The next step of this process is re-coding the (phonemic) acoustic
units
components of the speech - phonemes - in visual units of the
writing process - letters or graphemes. That requires the participat
parts of the brain - especially those of visual (occipital) p
of the cortex and spatial (parieto occipital) zones parts of the cortex
close relations with the acoustic (temporal) zones. That is wh
the writing process of writing is severely disturbed in case lesion
of the left temporo-occipital and parieto-occipital lesions; bu
the type of disturbances of it is in these cases very different fr
what we have described earlier.

Patients of this group don't feel any trouble to analyse the
acoustical constitution of the word, nor do they confuse their
phonemic elements. But they realise marked troubles
when they begin to re-code phonemes in letters or graphemes
the relation of letters with sounds is often lost, and the patient
begins to seek unsuccessfully the letter he needs, saying: „Oh, whe
is really the letter for „n" - that one, or that one?", or he

tries

~~the attempts~~ to find spatial relations of the elements of the
showing marked troubles in distinguishing the needed structure
(+) the letter from the mirror one, or being unable to combine se
rate parts of the letter in a coherent whole. All these difficult
are clearcut symptoms of lesions of the visual and spatial
of the cortex, and they can be easily ~~differentiated~~ distinguished from the sy
toms of lesions of acoustic or kinesthetic ~~pa~~ zones. ~~of the hemisp~~
We described the first two levels of the ~~writing~~ process of writi
and we come now to the last part of the process.
To write down a word does not mean to write a letter; i
is a whole word which has to be written, and the word consis
of a sequence of sounds and letters. That is why the subject h
to preserve a sequential order of the elements and to analyz
its serial organization.
Here we come to a new - and most significant point in the
~~Cort~~ organization of Higher Cortical Processes.
It was K.S. Lashley who found ~~40~~ thirty years ago tha
Spatial and sequential analysis are incompatible processes,
that ~~they are~~ different zones of the brain are required for
to their organization. ~~During~~ In special observations
fulfilled during several decades we found that with spatial ana
sis is provided by parieto-occipital parts of the cortex, seri
~~of~~ or sequential analysis requires participation of anterior
parts of the hemisphere, whether temporal (acoustic) or premo
That is why disturbances of ~~tempora-premotor~~ fronto-temporal and the low
parts of the premotor zones of the left hemisphere, result n
only in disturbances of ~~the~~ the prosodic (rhythmical) organiza
of movements, but in severe disturbances of serial organ
of speech and writing processes. Patients with such lesions
display severe difficulties in preservation ~~of~~ the sequence of
(x) in writing, ~~sometimes~~ change the position of separate letters,
the word, sometimes they are unable to proceed from one letter to a
(x) and often replace the needed serial order with an inert stereotype

If the lesion is located in the deep parts of the brain distu
bing the normal relations of the cortex with the basal ganglia
new symptoms arise - this time forced repetition of some frag
ments of the letter, and the patient becomes unable to write
although his acoustic analysis of the verbal sounds or
his spatial analysis of the components of the graphemes remain
intact.

May I only mention the last - but mostly important defect in
writing?

We don't write only letters or words; we express in writing our
intention and thoughts, - and when the apparatuses of the third block
of the brain are injured - and that is in cases of severe lesions of the
frontal lobes, - intention and plans are disturbed, and the patient
becomes unable to express his intentions and thoughts, both in a
verbal and in a written form. I can hardly forget a letter a woman
with severe lesion of the left frontal lobe has written to the famous
Russian Neurosurgeon Professor Burdenco. „Dear professor, she
wrote, I want to tell you that I want to tell you that I want
to tell you ..." and four pages of the letter didn't want a step
further!..

We have completed the long way of the psychological analysis of the
process of writing and of the symptoms of it disturbances
in cases of different local lesions of the brain. It was only
one example but we have learned important data on the
style of neuropsychological analysis of this model and its
disturbances in different local brain lesions.

We realised that a behavioural process can suffer in lesions
of different parts of the brain, but that in different local
ization of the injury the type of the disturbance is different.
That is why the work of the Neuropsychologist who wants to use
his method for a local diagnostics of the brain lesion is not in
a mere statement that the function is disturbed but rather in a
qualification of the type of the disturbance, in finding the primary
defect underlying this disturbance and in description of all secondary
or systemic disorders following this primary defect.

We have chosen disturbances of writing as ~~an example~~ a model of such analysis; but we could as well use as an example the Neuropsychological analysis of perception or movement, of memorizing or concept formation, of ~~fulfilment~~ fulfillement of a planned action or problem solving.

During last five decades we made an the analysis of the differences of the disturbances of all these processes in local brain lesions and we showed how a detailed ~~description~~ description of the ~~kind~~ kind of these disturbances can be used for a local diagnostics of brain injury.

And that is the basic method of Neuropsychology

4.

We have seen ~~that every zone of the cortex takes its own contribution to the organization of~~ each local Neuropsychology can be used as a valuable method in a local diagnostics of a brain injury. ~~every complex behavioral process and the local significance of the symptoms can be obtained by singling out this primary defects evoked by local brain lesion and by showing how the behavioral processes suffer in case of such primary defects.~~

But Neuropsychology is not only an applied branch ~~is~~ of psychology Science; it is a self sustained Science as well; and that means that important theoretical sequence can be ~~made from this general principle~~ drawn from Neuropsychological investigations.

When we say that each cortical zone ~~takes~~ takes part in the organization of behavioral processes in its own way, - we ~~say~~ are saying that new ways to an analysis of special factors included in behavioral processes ~~are opened~~ can be discovered, and that a really new approach to the factor analysis of complex psychological process ~~becomes~~ can be used.

You all remember the efforts made in psychology to discover separate constituents of the psychological processes and to learn more about the inner structure of complex behavioral ~~aptitudes~~ capacities. Complicated methods of intercorrelation of the results of batteries of different tests in various populations were used, and it is enough to remember the names of such brillant scholars as Spearmen and Thurstone, not mentioning

more recent names, to evaluate all the efforts made ~~in this~~ to solve this problem.

Neuropsychology ~~of~~ opens a new ~~ways to the~~ kind of psychological factor analysis, and that is a factor analysis on one person.

If a local brain lesion results in a disturbance of one of the factors included in a complex behavioral process (acoustic or kinesthetic analysis, spatial organisation of the input or sequential organization of ~~this behavior~~ psychological processes – ~~it leads to a~~ clear-cut secondary results are observed): all complicated behavioral processes which include this factor ~~as a basic component~~ become disturbed, and all behavioral processes in which this factor is absent remain intact. We know from our clinical observations that, in cases where lesions of the left temporal cole results in defect of acoustic analysis of speech sounds, ~~singling out phonemes is disturbed~~ – perception of speech, repetition of verbal sounds, naming of objects and writing become severely damaged, but orientation in space or simple calculation remain intact. On contrary, cases of lesions ~~of lesions~~ of the left parieto-occipital cortex, which destroys ~~orientation in space~~ simultaneous or spatial organisation of the information is closely associated with disturbances of complex ~~practical~~ or symbolic deficites ~~praxis, of counting~~ etc. – and don't result in any dissolution of fluent speech or ~~music~~ prosodic melodies.

That opens new vistas in the analysis of factors underlying different behavioral processes. We can easily observe how different psychological functions are interrelated in one person, and which group of functions have common factors.

Three mean tasks become possible by using this method of analysis: we can finding basic differences in quasi-similar processes; we can discovering common factors in processes which seem at the first glance seem different; and we become able to evaluate the different structure inner structure of the same behavioral processes at different stages of their functional development.

Let us examine these three problems separately.

There are psychological processes which seem to be closely related if not identical in their components, although that relationship is

so easy
not proved. An example of such processes is ~~the speech and musical~~
acoustic perception of verbal
~~hearing for speech~~ and musical sounds.
Neuropsychological investigations give unexpected results: as it was
shown by several authors lesions of the left temporal lobe result
discrimination of phonemes
in marked disturbances of ~~phonemic hearing~~ while musical hearing
remain undisturbed. I had an opportunity to observe during three
years an outstanding Russian composer who had a haemorrage in
the left temporal lobe, suffered with severe sensory aphasia, was
unable to single out verbal sounds and understand oral
speech, but who created during these years magnificent sym
phonies. Doesn't it prove that there are very different factors in
these two processes, which seems to be so close from the first glance

There are some psychological problems of an opposite type. Several
behavioral processes seem to be so different that one can hardly find a
common factors in them. What can be in common in orientation
in space, calculation and understanding of complex logico-gra
matical structures? The analysis of this problem by means of the N
psychology can result in a very unexpected conclusion. It is well
Known that lesions of the left inferior part of the left parieta
inevitably
gone result in disturbances in orientation in space, which are associated w
in calculation and in an inability to understand complex logico-
grammatical constructions? Doesn't it mean that there are common
factors in such quasi different behavioral processes?
A close analysis of these data show the nature of these common facto
To substract make a substraction 31 - 7 one has firstly to substra
fulfill
~~make~~ an operation 30 - 7 = 23, and then to add the remaining "1
That is easy for a normal subject; but a patient with lesions of
the left inferior parts of the left parietal lobe is unable to do this
he wonders if he has to place the remaining "1" to the left lef
or to the right of the ~~intermediate~~ obtained
results - ~~or~~ in other words to
add or to substract it, and he fails in this operation. It is clear th
more
other ~~more~~ complex arythmatical operations remain totally unac
sible to him ~~because of the same ground~~. as a result of the same
defects.
The same can be said about the understanding of complicated, relation

logico-grammatical forms.

To understand the difference between such constructions as „father brother" and „brother's father", „The cross under the triangle" or „the tri under the cross", „The ~~spring is~~ summer is after the spring" or „the s is after the summer", as well such well known relational constru as „Jenny is darker that Kate but fairer than Ann", — one has to the elements of this construction in an inner space and to grasp quasi spatial relations between the alternative mentioned. That why lesions of the inferior parts of the left parietal zones, elimina the ~~a~~ factor of simultaneous spatial synthesis result in disturbance these complicated forms of verbal behavior.

It is clear that both the discovery of ~~common factors in~~ + diffe of very similar ~~behavioral~~ processes and of common factors in ver different behavioral processes is of a very high importance, and w can suppose the structure of the future psychological science wi highly differ ~~a~~ from its modern structure, and Neuropsychology will play ~~of~~ a decisive role in this development.

May we now pass to the last question which is of a high p chological interest?

It is well known that after a certain period of training behavioral processes can be automatized and that highly ~~pla~~ organ skills can be developed.

~~Does~~ Does it mean that in this process the whole ~~structur~~ structure of the psy logical process becomes changed and that its cortical organizat receives new forms? One can hardly answer this question by ordinary psychological ways; but for Neuropsychology the sol of this problem often becomes ~~evident~~ not too difficult

We know all right the famous example of Bowers patient being instructed to repeat ~~no~~ the word „no" said after a series trials unsuccessful ~~efforts~~: „No, doctor, I can't say „no"..." ~~Si~~ ~~The~~ when the patient with a focal brain lesion becomes unable to fill a new and unhabituated task but has no difficulties in f filling ~~it~~ the same action in an automatized way are very comm in clinical observations. We remember very clear an old lady who had a haemorrage in the left temporo-parietal part of the co

and who was totally unable to write a word; but if s
was asked to write a phrase very quickly, - she did it wi
hesitation. Observati· cases when ~~atemporal~~ patient
with lesions of the ~~temper~~ left temporal lobe don't wri
but preserve written signatures, are very often observed by dic
local brain injuries. ~~obvious~~ in the clini
Doesn't it mean that ~~the whole psychophy· den~~ training o
result in a ~~basic ch~~ significant change of the whole
~~structure of~~ psychophysiological structure of the behavio
process, ones that functions, which required a complex
acoustico-kinesthetic analysis now can be realized with s
motor stereotype based quite on different ~~assemblies of nervou~~
tical zones?

The ~~que~~ problem of the essence of the functional developm
of behavioral processes is one of the most intriguing problem
of psychology; it could be only expected that Neuropsychol
will find its ways ~~for~~ to help in answering this question.

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We tried to do our best to describe the basic features of
Neuropsychology as a Science. We have tried to show its c
associated with the successes of modern Neurosurgery, its pr
cal application and its ~~theor~~ significance for the psychology
theory.

We are sure ~~that~~ Neuropsychology - this youngest branch of p
Chological sciences is standing now on terra firma and
it will ~~be~~ find its important place in the solution
of the most complicated problems divisions ~~of our science~~ of
Human Behavior.

June 1968.