NEUROPSYCHOLOGY as a Science

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Neuropsychology as a science

During the last ~~decades~~ years a new branch of applied (as well as general) psychology has developed, - and that is NEUROPSYCHOLOGY. This branch is very important both for the ~~clinical~~ practical problems of the Neurological ~~Clinic~~ Medicine and for the theoretical problems of general psychology. The latest years were a period of ~~the~~ consolidation of this important branch which has now become an indispensable part of ~~clinical activities~~ the psychological service in the Neurological ~~[illegible]~~ clinics.

~~That is why I chose for this Evening Lecture~~

~~Dear~~ It happened that I was a witness as well as a direct ~~[illegible]~~ ~~the~~ participant of the ~~[illegible]~~ formation of this branch; that is why I ~~chosen~~ have chosen ~~the~~ for this Evening lecture the topic of "Neuropsychology as a Science".

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The last few ~~decades~~ decades were a period of a vivid development of a new important field of medicine - Neurosurgery.

I still remember a time - some fourty years ago - when brain tumors were supposed to be incurable, and the diagnosis of a brain tumor - malignant as well as benign - was equal a death sentence. I remember a time - perhaps ~~only~~ some ~~[illegible]~~ fifteen - twenty years ago when an acute hemorrage which resulted in a hematoma of considerable volume - was treated only in a conservative way and when a diagnosis of intracranial hemorrage was ~~equal to a sentence of a totally fatally incurable disease~~ signified a fatal ~~and~~ disease.

During the last few years the situation has changed. ~~Intra~~ Brain tumors as well as intracranial hemorrages have become an object of ~~a~~ surgical treatment; improved method of antiseptics, ~~blood~~ stoppage of bleeding and ~~[illegible]~~ of preventing ~~of~~ of brain swelling, as well as the of anestletic procedures ~~and regulation of the course of operation~~

made it possible to remove brain tumors and hematomas, to stop the bleeding and to prevent the brain oedema, which sometimes were even more dangerous than the pathological process itself.

Now we do not regard the diagnosis of brain tumor or hemorrage as totally fatal, - and we try to do our best to save the life, and if possible - the working capacity of our patients giving them a radical and an early medical help.

That means that two basic problems are now most important:

- early and precise topical diagnostics of the injury, to make duly and proper intervention possible, and
- rehabilitation of the patient after the surgical accomplishement of the intervention.

Both problems can be solved only with a close participation of psychology.

We shall begin with an analysis of the first of these problems, and only after we make it clear we shall pass to the second.

2.

To achieve early and precise local diagnostics of a brain injury is not at all an easy problem.

The soft tissue of a tumor or a hematoma does not considerably differ from the soft tissue of the brain, - and an X-ray examination gives only limited information about the site of the pathological process. That is why an excellent technique of pneumo-encephalo-graphy (which makes it possible to observe the changed contours of the brain ventricles), and that of artheriography - injection of contrast fluids in the arteries of the brain (which allows to record the course of the brain vessels) can be of decisive significance in the localization of the brain tumor, aneurysm or hemorrhage

But these contrast X-ray method can't always be applied easily and that is why different - indirect or

functional methods of local diagnostics of the site of the injury are to be used.

One of these methods is Electro-encephalography — recording of Brain potentials; another is a sophisticated neurological (as well oto- and ophtalmo-neurological) examination of the patient.

The brillant development of EEG-studies during the last decades has turned Electro-physiology into an important component of the diagnostic procedures in the Neurosurgical clinic. But no matter how precise these methods are, they are not able to give in all cases absolute data on the localization of the injury. Marked displacement of the brain tissue, which accompanies most of the brain tumors, as well as factors of repercussion - reflectory changes of the cortical activities - impede even this valuable method, which is now one of the basic components of clinical diagnostics.

An elaborate Neurological analysis of a case, which was the result of a century-long clinical practice remains the leading part of the local diagnostics of the injury even now. That is indeed an important, functional approach to the problem. We have now good knowledge of the functions of several parts of the brain stem and brain hemispheres, and the significance of several neurological symptomes (such as loss of sensitivity, paresis, hemianopia) are of great value for local diagnostics of injuries.

But Neurological data — basic as they are — have nevertheless to some degree limited.

The Classical Neurological examination of the patient deals with symptoms of changes in sensations, movements, tone and reflexes. But it is well known, that only a limited part of the

Fig. 2. Cortex is involved in these activities; more than 2/3 of the human hemispheres have nothing to do with sensation or direct motor impulses, and the change of the tone and reflexes can be only an ~~indirect~~ symptom of a pathological process in the subcortical areas or an indirect symptom of ~~the~~ disorders in the hemispheres. The predominant part of the human brain and of its cortical structures is a complicated apparatus of the highest forms of human behavior, dealing with the reception and coding of information, elaboration on of behavioral ~~or~~ plans and programs which ensures ~~of behavior, providing the most complicated forms of~~ a the regulation of the psychological processes.

That means that only a very careful and sophisticated study of behavioral changes made by ~~an only~~ a highly experienced ~~educated~~ psychologist can provide a great amount of important ~~most significant~~ information about the local ~~circumscribed~~ brain lesions, situated in these complex parts of the brain.

~~It is evident that disturbances of these parts of the brain don't result in the significant marked changes of sensation and movement as well as tone and reflexes, but are accompanied by appreciable ~~marked~~ changes in ~~of~~ complex ~~complicated~~ forms of human behavior.~~

~~There is one important considerable consideration which can become ~~an~~ a considerable obstacle for using psychology as a method for a precise local diagnostics of a brain injury.~~

Now we have come to a basic problem: can psychology really be of any help in a precise and early ~~dia~~ local diagnostics of a brain injury?

There are two serious ~~important~~ obstacles on the way of solving this problem ~~for a positive answer to this question~~: one is of a theoretical nature, the second of a practical one ~~nature~~.

It is evident that psychological processes - ~~both~~ ~~whether complex forms of cognition or and of conscious actions~~ are very complex ~~complicated~~ functional systems, social or historical by origin, ~~which using several~~ indirect or symbolic ~~using by~~ in structure and conscious or voluntary by their functioning.

The concept of psychological functions as isolated, ~~irreducible~~ indivisible faculties ~~is long ago~~ was abandoned rejected long ago and can be now found only in the ~~Tretea~~ treatises on the ancient history of psychology.

That means, that no ~~circumscribed~~ ~~isolated~~ separate groups of ~~isolated~~ nerve cells or ~~reg~~ isolated regions of the brain ~~can be~~ are responsible for ~~separate~~ complex ~~funct~~ disorders of behavior. ~~and~~ That ~~the~~ is why the idea ~~to find~~ that ~~certain~~ certain complex processes ~~actions~~ changes of psychological ~~functions~~ (such as understanding of grammatical forms or calculation, writing or reading) can be ~~used as direct~~ regarded as ~~or~~ resulting from ~~symptoms of circ.~~ ~~circumscribed~~ local destruction ~~of circumscribed~~ destruction of definite "cortical centers" – ~~is~~ ~~seems~~ to be ~~false~~ discarded as fully erroneous from the beginning.

If so – can ~~really~~ a psychological analysis of behavioral changes ~~through as it can it~~ be of a use for ~~the~~ precise and early ~~di~~ local diagnostics of a brain injury?

The second obstacles is of a practical nature, and it is closely related to the first. ~~The majority of~~ Most of the existing psychological tests ~~as they exist~~ ~~are created~~ have been elaborated for purposes very greatly differing from those we are discussing here; They are ~~constructed~~ designed to measure complex cognitive ~~a~~ ~~or intellectual~~ processes, the levels of general intelligence ~~level development~~, some individual ~~trait in emotion~~ emotional ~~disposition~~ traits or individual differences. It is ~~a~~ only too evident that such kind of tests are useless for ~~a~~ precise ~~di~~ local diagnostics of a ~~circumscribed~~ circ brain lesion.

To ~~overco~~ overcome these obstacles we have to clarify some basic problems of psychology: ~~and first of all – our understa~~ ~~&~~ our understanding of the ~~psy~~ structure of the psychological processes or psychological functions ~~the~~ ~~themselves from one side~~, and ~~our basic~~ the ~~basic~~ modern concepts of the construction of the brain, on the other on the one hand

Only then can we return to our general problem ~~of the inter~~ concerning relation ~~of~~ between the behavioral processes and the brain structures, and ~~to answer~~ solve the problem of ~~the how can we~~ the proper use of psychological methods for ~~our~~ early and precise local diagnostics of ~~the~~ a brain lesion.

3.

As we already mentioned, behavioral processes ~~are complicated~~ such as perception or memorization, concept formation or decision making, writing or reading, - are complex self-regulating systems, based on a ~~compl~~ constellation of different ~~cortica~~ brain levels and cortical zones which ~~enter in a complex~~ form dynamic assemblies. That is why ~~serious~~ even ~~circuitr~~ lesions of circumscribed cortical areas can result in ~~dis~~ a disintegration of the whole functional system and in marked disturbances of the complex psychological functions. Does ~~that mean all~~ all this mean that in ~~all~~ cases of local brain injuries the ~~distur~~ disturbances of psychological processes are always ~~the~~ of the same structure and that it is really impossible to apply psychological ~~analysis of~~ methods to ~~our principal goal~~ achieve to ~~the~~ early and precise local diagnostics of the lesion?

Only ~~a~~ one generation ago ~~it was thought th~~ a number of outstanding scholars supposed that the grey matter of the brain is a homogenous field and that separate parts of the human cortex are ~~of an~~ equipotential, ~~character~~; that is why such psychologists as K.S. Lashley and such neurologists as ~~K. Mo~~ C. Monakow or K. Goldstein were ~~near~~ almost ready ~~close~~ to ~~the assumption~~ assume that every local lesion of the brain results in a lowering of the level of psychological functions, ~~the~~ and in the end leads to a reduction of abstract attitudes or ~~categorical~~ conceptual thinking. If so - ~~the~~ any attempt to use psychological studies for a local diagnostics would fail, and the ~~Neurological fi wast~~ vast ~~the~~ field of Neurology and Neurosurgery would be closed for psychologists.

Fortunately enough, the last decades of ~~the~~ scientific progress ~~of Scienc~~ showed that the idea of the equipotential ~~ali~~ nature of different cortical zones ~~is~~ was ~~an error~~ wrong, and that the cortical fields as well as subcortical brain stem formations ~~are very diff~~ are to be considered as ~~a very~~ highly differentiated in their ~~struct~~ structural connections and their ~~fun~~ immediate functions. That is why ~~they~~ they by ~~it~~ no means ~~any~~ ~~care do they~~ play the same role in the organization of behavioral processes and ~~why~~ we may state with confidence that ~~every cortical fore~~ each part of the brain or ~~every~~ each cortical zone ~~plo~~ makes its own

contribution to the behavioral processes and plays its own very specific role in the organization of the psychological functions

Let us ~~make~~ clarify ~~this~~ (this point ~~clear~~ ; later on we ~~have to~~ shall draw important conclusions from ~~that~~ this basic statements

Now it is well known that ~~separate~~ no separate part of the brain ~~has~~ is to be considered as an isolated "center" ~~or~~ of ~~a~~ a complex ~~complex~~ psychological ~~system~~ function, and that the ~~ideas of classical localization~~ classical concepts of ~~the~~ strict localization ~~are~~ very long ago abandoned, ~~a place in the museum of ancient ideas close to the ~~[illegible]~~ concepts of the mind as a collection of separate inborn faculties~~. But in no case does it mean that the contribution of ~~every~~ each part of the brain or ~~every~~ each cortical zone to the behavioral process is ~~the same~~ identical

Now We know ~~now all right~~ well that the wonderful apparatus of the human brain – the ~~most highpoint~~ crown of ~~the~~ Natural evolution – includes at least three basic blocks, ~~and that~~ each of them ~~contr~~ making ~~to~~ its own contribution to the organization of behavioral processes.

After the brillant discoveries of Magoun and Moruzzi, Jasper and Lindsley it became clear that ~~[illegible]~~ the ~~[illegible]~~ of the brain stem and reticular formation which are in the closest relation to the ~~whole~~ cortical fields (especially with the limbic systems and the anterior parts of the hemispheres) provide an optimal tone to the cortex and are considered to be a ~~so~~ kind of ~~[illegible]~~ an Energy Block of the Brain. It became clear that the ~~normal~~ function of this block is of a decisive importance for the normal flow of ~~[illegible]~~ each behavioral process, and that every lesion of this blocks which result in a lowering of the tone of the cortex can ~~impair~~ not only impair normal stability of ~~mental processes~~ the memory traces, but in some cases be of a considerable role responsible for a deterioration of the high selectivity of mental processes. ~~[illegible]~~ ~~is~~ To understand ~~the~~ this it is sufficient to remember the ~~finding of~~ Pavlov's ~~[illegible]~~ description of the change of higher nervous processes in cases of the low tone of the cortex accompanied with what he called ~~[illegible]~~ its "inhibitory

states. ~~You may remember~~ It was Pavlov who showed, that ~~its~~ while in normal tone of the cortex strong or significant stimuli ~~can~~ evoke strong reactions and weak or insignificant stimuli – weak reactions, – in the inhibitory states of the cortex both strong ~~or~~ (or significant) and weak stimuli ~~&~~ evoke ~~&~~ equal reactions, and ~~in~~ when the inhibitory state increase – weak stimuli begin to evoke even stronger reactions than the strong or significant ones. Let us remember how deeply is disturbed the ~~&~~ highly selective organization of our through processes in a waking ~~state~~ brain and how disturbed ~~becom~~ this selectivity becomes during the drowsy states...

That is what the brain stem formation contribute to the flow of the higher cortical processes, and it is evident that in cases of pathological state of these formations the ~~selectivity and stabili~~ stability of ~~mental processes~~ memory traces and the selectivity of the mental processes suffer. During the last years we described ~~the~~ such ~~the~~ behavioral changes in cases of lesions of mesial parts of the frontal lobes ~~so in~~ in a paper published jointly with our friend Dr Macdonald Critchley and we still are continuing to study as carefully as we can the specific contribution of these parts of the brain to the organization of each psychological process.

The second ~~which~~ Block of the brain is of a very different nature and its contributions to the organization of human behavior is very different. This block includes the posterior parts of the hemispheres of the human brain, and we ~~&~~ may designate it as a block of input, coding and conservation of information received by the organism from the external world. Some very definite features are seen in the work of this block and in ~~the~~ its participation in the organization of human behavior. ~~#~~ We shall mention only two of these basic features.

The ~~E~~ apparatus of the input, coding and conservation of information included in this block ~~are big~~ have a highly modality specific organization: every neurologist knows well

that occipital parts of the Human Brain deal with reception and coding of visual signals, while the temporal parts of the hemispheres deal with acoustic, and postcentral parts with tactile and proprioceptive signals, (~~This high highly~~ modality specific ~~kind of organization differs this Block from the first "unspecific" one~~) and ~~dist~~ lesions of occipital parts of the brain ~~The seco don't result in any disturb~~ which bring considerable defects in the organization of the ~~acoustic~~ optical and optic spatial perception don't result in any disturbances of the acoustic or tactual sphere. This modality specific form of organization differs this Block ~~&~~ from the first, "unspecific" one we have already described.

The second feature of the ~~organiz~~ functional organization of this Block is even more important, and it is a hierarchical principle of its organization.

It is well known that the processing of every modality specific -visual, acoustic or tactual - input starts with its cortical reception which is the function of primary (or extrinsic) zones of each functional unit of this block. This primary (or extrinsic) zone with a highly developed fourth (or receptive) layer of the cortex ~~is engaged in splitting the complex~~ contains billions of very specialized neurons which - as it was shown after the brilliant studies of Hubel and Wiesel, Jung and other outstanding scholars - react to ~~very~~ highly specialized features of the signal (brightness, or colour tone, curved or straight lines, direction of movements in the visual field etc.) - and they are engaged in splitting the signals in a large quantity of components, thus making ~~the sig~~ them accessive for further organization. If ~~this~~ parts of these primary or extrinsic zones are distroyed - very specific and limited defects in sensory processes are seen, ~~but no disorganis~~ which are easy compensated by higher levels of organization, ~~as~~ and no disorganization of behavior follows.

The second ~~step of the or~~ level of every ~~sen~~ functional unit of this block is formed by secondary (or ~~extr~~ intrinsic) zones ~~areas~~; here the 2nd and 3rd levels of the neurons (regularly known as associative units) are highly developed, and so far we know

(V) All kinds of ~~what is called~~ "agnostic" disorders ~~is~~ are the result of such lesions.

These secondary level of ~~organ~~ cortical ~~organization~~ apparatus of ~~the~~ input ~~of~~ is highly responsible for ~~organizer~~ functional organization of the input in highly structuralized dynamic assambles which allow to single out most important cues of the codes and to integrate ~~them + the~~ separate features in coherent wholes. If these ~~parts~~ zones of the brain are injured, ~~a~~ the patient fails in the organization of these modality-specific structures, ~~in~~ he ~~cases to~~ becomes unable to perceive optical things as simultaneous wholes or to code separate acoustic features in complex phonemes or successive ~~musica~~ melodies (V) I have ~~discussed~~ tried to analyse neuropsychological results of lesions of ~~a~~ secondary parts of ~~a visual~~ visual (occipital) and acoustic (temporal) regions of the brain in a series of publication, and I shall not dwell ~~in the~~ further in the description of this group of disturbances. It may be said that ~~defects~~ functional defects of such lesions remain to be highly modality-specific, although the level of the disturbances of the function is here much higher.

~~(We do not yet know enough about the functional organization of the third level of this Block, although it is widely known)~~

We don't yet have a good and full information ~~about~~ about the third level of this Block, ~~to~~ which may be ~~called~~ designed as tertiary areas of the cortex. As it was mentioned ~~above~~ by P.F. Flechsig already 80 years ago - this part of the cortex which he ~~designed as~~ described as a posterior associative zone, is ~~a~~ the latest product of evolution; ~~it is his~~ it becomes highly developed only in Man, and ~~it~~ its myelinization is completed only ~~at 5-7 years~~ in children of 5-7 years; it ~~consis~~ entirely consists of the most complicated neurones of the 2nd and 3d level of the cortex, and can be regarded as a zone of overlapping of cortical fields of different modalities. That is why no marked deterioration in separate inputs are seen (in cases of its injuries), but ~~to~~ the patient becomes unable to combine separate impressions in coherent wholes and to form complicated simultaneous systems

of traces, which are absolute necessary for complex cognitive operations.

The processing of input, coding and conservation of information which is the basic function of the posterior parts of the brain is ~~only~~ does not complete psychological processes; it is rather only the first step to elaboration of active programs of behavior. And it is the task of the third block of the Brain to provide necessary nervous basis for this last stages. That is why we may ~~call~~ design the Third Block - which includes anterior parts of the hemispheres ~~the~~ as the ~~apparatus~~ central apparatus of programming, regulation and control of human actions.

Although I spent more than 30 years in studying the psychological effects of the lesions of the frontal lobes, - I shall dwell on their functional organization only in brief.

The third block of the Human Brain has as its base the anterior convolution which is the primary (or extrinsic) motor zone - a zone of the outlet of motor impulses; it has a highly developed 5th layer - that of the big pyramid cells, and is highly specific - this time the specificity being not a sensory, but a motor one. Everybody knows that local ~~lesions~~ destructions of this area result in lesions of motor impulses, limited according the area of the lesions - by paresis of arm or leg of the contralateral side. No complex behavioral disfunctions are seen in these cases of the breakdown of the motor outlet of one of the ~~not~~ muscle spheres of the body.

The secondary areas of the motor cortex are represented by the premotor zones, which preserve the same motor (vertically organized) type of the cortex but differ from the primary motor zones by the highly developed 3rd layer of the small pyramides. ~~Its destruc the~~ Lesions of this area don't result in a paresis but bring a deterioration of a successive organization of movement; ~~in~~ that is why kinetic melodies or skilled movements ~~or~~ become disorganized in lesions of this zones. I have described the „premotor syndrome in a series of publications and shall not dwell further on this very important and very peculiar function of this zone.

The most important feature of this ~~third~~ Block of the Brain is that in Man a highly important third level, ~~of~~ superimposed

to the areas already mentioned is ~~seen~~ developed; it occupies nearly a third of the ~~a~~ human hemispheres, becomes ready only at the 5th - 7th years and plays a most important role in programming, regulation and control of the highest forms of behavior.

The Frontal Lobes - this tertiary level of the anterior parts of the ~~Cerebr~~ Hemispheres - remained during a long time a ~~the~~ no-man's land, a silent area of the brain: its lesions don't result in any deterioration of sensory and motor processes, and the perception, memory or speech remain undisturbed in patients ~~with~~ even with severe lesions of ~~of~~ the frontal lobes; their deficit cannot be expressed in terms of classicous ~~Only in the~~ Neurology or ~~the~~ in terms of the classical Reflex Arc.

Only in the latest time it became clear that these parts of the brain deal with the most complex forms and with the highest level of the ~~progra~~ goal-linked, self-regulatory human conduct. When the Prefrontal zones of the brain are severely disturbed, the patient becomes unable to form ~~stable~~ intentions, to preserve stable programs of behavior, to construct a chain of ~~actions according~~ selective, ~~or~~ organised actions according these ~~a~~ intentions or programs; the programs of behavior he starts are easy broken by every ~~external sti~~ outside stimulus; immediate orienting reaction to these stimuli ceases to be blocked by the dominating program, and complicated plans of action are easily replaced by senseless stereotyped or primitive impulsive reactions. ~~The~~ Realisation of a conscious, goal linked ~~or~~ and programmed activity becomes ~~im~~ impossible, and the patient's ~~loses~~ behavior loses its most human features of an active ~~beto~~ conduct governed by some future goals. These defects are only one part of all behavioral disturbances clearly seen in patients with severe lesions of the frontal lobes. A second - and very significant ~~loss~~ feature of their behavior is the loss of control of their behavior: the process of matching

the effect of actions with the preliminary plans of intentions becomes impossible, ~~and the~~ no adequate evaluation of mistakes and no correction of errors becomes possible. Thus – a really basic ~~the~~ breakdown of the complex self-regulated human behavior is a result of lesions of these very important zones of the brain.

A series of investigators – my colleagues in the USSR, Pribram (Denny-Brown) and others in USA has studied the Neuropsychological effects of these lesions in details, and I will not continue here the description of the functional disorganization of behavior following the lesions of ~~these~~ the Frontal lobes.

I have to add a last moment which is very important for the understanding the functional organization of the Human Brain – and this is a very peculiar principle of lateralization of its functions.

It is well known that the left hemisphere in right handers ~~deals wi~~ is much more differentiated (the latest publications of Josephine Semmes ~~give a good deal of~~ proves that very nicely) and is responsible for the speech ~~processes~~ and all ~~behavioral~~ psychological processes depending ~~of~~ on the verbal organization of behavior, while the ~~be~~ right (subdominant) hemisphere is less (~~of these functions~~) differentiated and not involved in this kind of behavioral processes.

~~If we hold in mind this last statement, our basic approach to many a great account of our knowledge on the functional organization of the Human Brain will be clearer for us than it was before.~~

How different are then modern concepts of the functional organization of the Human Brain from the old and ~~very~~ highly simplified ideas of strict localization ~~by~~ of complex mental abilities in circumscribed cortical centers or the ideas of the equipotentiality of different zones of the Human Brain!...

4/.

Having the modern conceptions of the functional organization of Human Brain, may we now return to our starting question:

- How can we use the study of psychological processes for diagnostics of Local Brain Lesions?

It is now clear, that complicated forms of human behavior are not localized in circumscribed areas of the cortex, ~~and that every part of the brain makes its own contrib~~ that they are widely spread over ~~large~~ parietal broad assambleys of cortical zones ~~every~~ each of these zones making its own contribution to the ~~functions~~ realization of the functional systems. That means ~~we had~~ our basic task will be (~~to find out not to make a simple stat~~) not to restrict our ~~clinical~~ work to a simple statement of ~~symptoms~~ behaviorae losses occuring in local brain lesions (loss of speech, of reading or writing, disturbances of calculation) but to make a sophisticated analysis of the kind of disturbance of the function, to describe how the function is disturbed; only such an approach can ~~result~~ help us to single out the ~~factor~~ basic factor underlying this disturbance, - and thus to use psychological symptoms for a local diagnostics of the injury.

But this way ~~requires~~ requires a ~~sep~~ careful and sophisticated psychological qualification of the symptom, and only ~~using~~ such an approach (which differs basically from the ~~regu~~ ordinary application of ~~psychological tests~~ psychometric tests) ~~can~~ can ~~be~~ be efficient in the practical work of modern Neuropsychology.

Let us show this basic principle on ~~one~~ an exemple.

I could easily ~~take for our~~ use for that purpose a description of how we use a study of changes in perception ~~of~~ or memory, motor activity or information processing, ~~problem solving or~~ communication or problem solving, resulting ~~for~~ from a local brain lesion, and show how we use a careful psychological analysis of ~~the~~ pathological changes of these processes for local diagnostics of the lesion in Neurosurgical wards. I have described it in a rather long series of ~~bo~~ publications, - and therefore I shall ~~limit~~ restrict our analysis only by one exemple.

~~I shall o~~ For didactic purposes I shall chose for such an exemple the ~~analysis~~ study of writing and its disturbances and

show how ~~we can~~ a careful psychological analysis of these disturbances can give us an invaluable information for the ~~local~~ local diagnostics of the ~~basic local~~ brain lesion.

~~It is well known that~~ The naive idea that the process of writing is based on an activity of a circumscribed ~~„writing centre"~~ zone of the cortex and ~~is disturbed~~ becomes disturbed after a lesion of the „Exner's centre" is abandoned long ago; ~~it~~ now it is well known that the process of writing can be disturbed in lesions of ~~a series~~ widespread lesions of the left ~~hemi~~ cerebral hemispheres. But ~~that a~~ this fact doesn't at all mean that ~~the~~ disturbances of writing cannot ~~become~~ ~~no~~ be used as ~~a~~ very definite symptoms of the localization of cortical lesions.

Let us start with a psychological analysis of the process of writing and let us try to show what groups of cortical zones are involved in this process.

To write down a word (dictated or inwerly planned) one has first of all to analyse the flow of sounds which constitute the speech and to single out definite ~~acoustic units or~~ ~~cues~~ cues ~~which are the acoustic basis of human speech~~ phonemes which are the ~~see~~ acoustic units of ~~cues~~ human language, ~~known as~~ widely known as phonemes. These cues are different in different languages, and if for an English speaking person „v" and „w" are perceived as ~~very~~ different sounds which enables to ~~differenti~~ discriminate ~~the~~ meanings of words (cf „vine" and „wine") – for a Russian, whose language does not use the fricativeness as a differential cue both words are perceived as ~~very similar and~~ hardly ~~a~~ pronounced. The same can be seen in a perception of ~~Russian~~ some Russian ~~language~~ words for an Englishman or Frenchman: the Russian language ~~has~~ uses a cue of softness, and Russian „и" and „ы", „л" and „ль" are perceived by a Russian as very different sounds, having very ~~precise~~ different linguistic meaning; but for an Englishman or a Frenchman the words ~~„Бык~~ „пыл" (fire), „пыль" (dust), „пил" (he drunk), or the words „был" (he was) and „быть" (truth) are hardly distinguishable. It is clear, that to hear the foreign language means ~~to perceive~~ to conceptualize it, to organize its sounds

in definite linguistic (phonematic) codes, and it is a fact, that we do not only fail to understand, but we fail to hear ~~chinese~~ chinese language which uses the pitch of a sound as a semantic cue and where „ma" means „to buy" and „ma" = „to sell". It is the same cause why a Russian as well as ~~German~~ Frenchmen, Englishmen or ~~a~~ a German are unable to ~~dist~~ hear the difference in Georgian words „Kari" (= door) and „K'ari" (= wind), „puri" (bread) and „puri" (oven), „cili" (albumen) and „c'ili" ( )

~~The pho~~ To ~~single out~~ detect separate phonemic cues and ~~to~~ to single out phonemes is a basic condition not only for ~~and~~ hearing and understanding a word, but for writing it ~~down~~ as well: ~~we c~~ our letters are symbols of isolated phonemes, not of ~~mere~~ un-coded sounds; that is why every ~~difficu~~ trouble in singling out phonemes make writing impossible.

But the modern ~~physiolo~~ morpho-physiology of the brain knows very definitely that it is the ~~the~~ convexitae part of the left temporal lobe which is ~~respon~~ a central ~~appo~~ end of ~~the acoustic analys~~ what Pavlow called the „acoustic analyzer"; it has intimate connections with postcentrae and prematae zones of the ~~brain~~ cortex and it plays a decisive role in acoustic qualification (coding) of different phonemes. ~~That is why~~ ~~It~~ ~~the cause why~~ That is why lesions of this part of the cortex results in severe disturbances of differentiation of similar (or correlative) phonemes typicall for a „sensory aphasia" and in a marked disturbance of the writing processes. ~~This basic fact That is why – if a neuropsychologist~~

Fig. This gives to a Neuropsychologist a new symptom, – and if the patient fails to discriminate opposite phonems („b" and „p", „d" and „t", or the English „v" and „w") and ~~is un~~ begins to make phonematic misteeres in writing (writing „table" as „dable", etc.) – the Psychologist can ~~be~~ hypothesise a lesion of the left temporal zone ~~underly~~ as a cause of this disturbances and try to find additional symptoms to make his prediction sure.

Fig.: (writ.)

Defects in acoustic ~~a~~ elaboration of phonemes are only one of many conditions necessary ~~from a normal~~ for writing process. Another component is a normal articulation of sounds ~~to be written~~, which the subject singles out to ~~write them~~ recode them in letters.

You had of course many occasions to observe a class of young school-children ~~who study are studying~~ during the writing lessons: There is every time a noise in the class – a noise of oral repetition of the words the children try to write. Teachers are not sure ~~whether~~ whether that permanent uttering of words is good or not. To answer that problem I asked one of my collaborators ~~Dr~~ ~~Ma~~ L. Nagerova to make a special experiment, ~~instructi~~ recording the childrens writing ~~down~~ in regular conditions, – and for a control – in ~~conditions of when the uttering was remove~~ condition when the uttering was removed children writing with a mouth open or with their tongue squeezed between their ~~the~~ teeth. The amount ~~in mistakes in the co~~ of writing mistakes increased in the control series six times!

The fact that to ~~q. improve the qualify~~ make qualify the sound and to single out its phonematic cues an articulation is necessary – ~~it~~ can be observed even in an adults analysis of sounds – mostly in the words with low probability of immediate understanding. – What is your name – B-a-a-m-b-e ?" one asks, and in articulating the name gains a precise analysis of its phonetic structure.

That is why articulation has to be regarded as an important component of writing, and if ~~the articulatio~~ a precise articulation is disturbed the ~~wri~~ processing of writing can suffer. But that is just the case in lesions of another part of the cortex – the kinesthetic divisions of the post-central zones of the left hemispheres. That is why in these cases local lesions of the brain result in ~~disorganized~~ disturbances of writing – this time of another kind.

I realized that many years ago when a patient with such localization of brain injury ~~a~~ made strange mistakes in his writing – confusing such sounds ~~an~~ – different in acoustic features but close in articulation as „b" and „m" or „d", „t" and „n" and writing „Stol" (table) as „Ston" (groan) or even „Slon" ~~telefant~~ (elephant), or ~~„Khalat"~~ „Khalat" (coat) as „Khadat" (senseless). Such articulatory mistakes in writing are very different from acoustic mistakes, and a high amount of such mistakes can ~~be a give a~~ make it very probable that in this case the ~~lesi~~ lesion is localized in post-central (kinestatic) part of the left post central zone.

Singling out separate phonemes is only the first preparatory step of the writing process. The next step is the re-coding of phonemes in letters or graphemes, - and this involves the participation of different, this time - optico-spatial zones of the cortex.

It is well known that the ~~optico~~ spatial organization of the signs is a function of the occipito-parietal zones of the hemispheres, and if these zones are impaired - a disorganization of optico-spatial relations take place. Patients with such lesions lose their ability of orientation in space, they mixup the direction of left and right, fail in recognition the relations of the hands of the watch or of direction in geographical map, fail in finding their way in the town or even in the ward, and begin to experience severe troubles in writing letters and words. However this time the difficulties in writing are of a kind very different of what we have already mentioned. A patient with lesion of the left occipito-parietal zone preserves the ability of singling out isolated sounds and of a precise qualification of phonemes. His troubles begin in a spatial organization of the graphic elements of letters: he confuses the spatial co-ordinates of the components, and mirror images as well as fall disorganization of letter writing is observed. Such defects are clear symptoms of occipito-parietal lesion, a spatial disturbances, and the localization of the lesion in parieto-occipital parts of the brain becomes very probable.

Fig.

Re-coding phonemes in graphemes is an important but not the last step of the process of writing. The next step is writing itself - i.e. the successive process of serial shifting from one letter to another. Thus writing words, phrases and paragraphs, and this process requires adequate placing of letters in a sequential order, blocking impulses already done and shifting from one series of impulses to another. It took many years of studies to make it clear that such a serial organization of processes involve a different group of cortical zones, that time a complex of parts of the hemisphere, placed anterior of the central convolution, - and especially the lower parts of the premotor zones of the cortex working in close connections with the temporal zones of the brain.

A long series of clinical observations and neuropsychological studies proved that disturbances of these parts of the

brain, leaving acoustic analysis of sounds and their re-coding in letters ~~undisturbed~~ normal, ~~and~~ can result in severe disturbances in placing letters in a required order, in ~~repea~~ anticipating strong and postponing week sounds, and – if the lesion ~~also~~ leads to a disconnection of premotor zone and the subcortical motor ganglia – even in a pathological inertia of a motor stereotypes and in a breakdown of ~~the~~ # shifting from one letter to another. Such kinds of writing disturbances are very often symptoms of lesions of premotor or fronto-temporal zones of the brain, and they have a quite different local significance that the mistakes in writing we already described.

Fig. –

Fig. –

~~Of~~ We are close to the end of ~~on~~ the ~~p~~ neuropsychological analysis of the processing of writing, and only few least parts have to be mentioned.

It is obvious that for writing a phrase or a letter one requires an intention and a plan, – and if that intention fails or the plan ~~of #~~ is insufficient, in other words when a transition from the intention to expanded speech suffers, – ~~no requis~~ the possibility of singing out phonemes or ~~wai~~ ~~zo~~ re-coding them in graphemes, even writing of words remains intact, but ~~no~~ ~~active~~ writing as a special form of communication is no more possible. But that is just the case of lesions of the frontal lobes which result in a breakdown of intention and plans, and where very special disturbances of the predicative function of the inner speech ~~suffers~~ are seen. That is why patients with lesions of the left frontal lobes (especially of their parts ~~lying~~ situated ~~ant~~ anterior to the speech zones can show the clinical picture of „dynamic aphasia", and their ~~active writing bec~~ neocortical communication by writing becomes impossible. ~~I hardly can forget~~ ~~Them~~ These patients complain that thoughts don't come in a proper order, that ~~they~~ their experience is full with ~~un~~ chaotical fragments of the plans, and sometimes they are even unable to write a sentence although they know every word ~~wh~~ they require. Such kind of writing disturbances has a very different significance and can be used ~~as~~ as a symptom of very probable lesion of the anterior parts of the ~~hea~~ cortex

We have made a very short review of different kinds of disturbances of writing observed in differently situated local lesions of the brain.

All we said proved that ~~be~~ a mere statement of writing disturbances ~~has~~ is of no value for a local diagnostics of lesion and can be only a symptom of very ~~be~~ ~~wide~~ different lesions of the left hemisphere. But a careful psychological analysis of the kind of disturbances of writing can ~~be a~~ single out the basic factor which underly the writing defect and can be of a great help for a precise (and sometimes of an early) local diagnostics of the injury.

We could very easy make a similar analysis of the disturbances of perception or movement, remembering or problem solving, each time ~~singling out the type~~ describing the type of the disturbance and singling out the ~~basic~~ basic factor which suffers ~~it~~ so differently in different ~~lesions~~ lesions of the brain; ~~to~~ that could show us the basic method ~~of~~ neuropsychology applies to the local diagnostics of the brain injuries.

I shall not do it, because in a series of books I tried jointly with my collaborators – Dr E.D. Homskaya, Dr L.S. Tsvetkova and others to do it. I only want to ~~a~~ stress that ~~neuropsychologic~~ I choosed writing disorders only as one example, and that my basic goal was to demonstrate the basic approach of neuropsychology to the very important problem – an early and precise ~~diag~~ local diagnostics of cerebral lesions.

5

After all we have said it is clear that every kind of psychological activity – writing and reading, ~~as~~ ~~per~~ active perception and memorization, counting and problem solving is widely spread over ~~large~~ broad territories of the cortex, and that ~~is~~ it is absolutely impossible to „localize" these functional systems in any circumscribed cortical areas.

But a second fact remains unclear. ~~Every~~ Neurologists know as well

that every local lesion of the brain result in a complex of disturbances, and that ~~practically~~ in cases of very circumscribed lesions of the brain (such as gunshot wounds) they practically have to do not with a single deficit ~~(disturb)~~ or monosymptoms, but with a whole battery of symptomes building what is called a syndrome. What is the cause of this fact? Why does a lesion of the left ~~afterall we have~~ temporal zone result in a deficit of understanding of language, inability to name objects, disturbances of writing while orientation in space and written arithmetic remain intact? And why lesions in the lower parts of the parietal zone ~~inevitable~~ are inevitable associated with ~~disturbances of such~~ such strange combination of symptoms as disturbances of orientation in space, inability to count and severe troubles in understanding compeicated grammatical relations, while orientation in time as well as spelling remain undisturbed?

After all we already said it is clear that even the idea of ~~sep~~ a complex of separate „centers" for these „functions" in a circumscribed area has to be rejected, and that the nature of ~~these~~ this assembly of symtoms in cases of circumscribed brain injury has to be studied.

The discussion of the ~~nature~~ disturbance of single psychological processes in local brain lesions we were engaged can be used to find a clue to the answer to this second question.

It ~~is~~ can be clearly seen, that if ~~a~~ the lesion of a circumscribed cortical area result in a breakdown of ~~a~~ a certain kind of elaboration of information or programming of action – and if ~~the~~ ~~the~~ immediate, primery result of this local lesion is the elimination of a certain factor, included in the functional system, – it becomes clear, that a whole group of psychological processes which include this factor becomes disturbed while another group of psychological processes which does not include this factor remains intact.

That is why the ~~analysis presence~~ analysis of a syndrome, resultons from a circumscribed cortical lesions ~~results~~ becomes ~~becomes at the same time~~ ~~in a~~ way ~~to make our local diagnostics of the injury most reliable~~, and ~~a practic~~ both for very important practical and theoretical consequences. Practically the analysis of the whole syndrome observed in local brain lesion can improve the reliability of our diagnostic predictions;

theoretically it becomes an ~~valuable~~ important method to study the inner relation of different psychological processes and to make ~~the~~ significant conclusions about their inner structure.

Let us make this point clearer ~~only~~ in one example.

As it was already said lesions of the ~~infero-~~ lower parts of the left parietal zone of the cortex result in marked disturbances in orientation in space as well as a very definite symbolic disorders.

These patients are unable to distinguish their own right and left hand or the right and left hand of the observer; they are confused when they have to find a right direction in the street or even in the ward, going left instead of right; they begin to have difficulties in evaluation of the position of ~~digits or~~ hands on the wach and are unable to draw a simple geographical map; they show disturbances in finger-naming and ~~sometimes~~ marked ~~a~~ loss of constructive abilities (named „constructive apraxia"). But ~~the~~ most remarcable is that these patient ~~s~~ display marked difficulties in counting, sometimes are unable to make a simple distraction and fail absolutely in complex operation of division (although well habituated multiplication ~~are~~ remains preserved); they have no difficulties in understanding of common sentences (which the linguists call „communication of events") but are absolutely unable to understand several relational grammatical constructions (such as ~~„brother~~ „fathers brother" or „brothers father", „a circle under the triangle" or „a triangle under a square" etc.)

What is the cause of such a strange syndrome which includes ~~apparently un~~ disturbances of apparently very different processes?

The only way to answer ~~to~~ this question is ~~the~~ to apply the principle we have already mentioned: if a circumscribed lesion results in a breakdown of a complex of processes, - it means that all these processes have a common factor and that they are not at all as different by their psychophysiological mechanisms as it might be supposed.

Let us closely examine ~~examine~~ the syndrome we just described. It is widely known that the infero-parietal zone of the cortex is a most complicated ~~and~~, tertiary zone where the central parts of

optical, tactual and labyrinthal analyzers are overlapped and which thus becomes an apparatus for an ~~spatial analytical~~ elaboration of spatical analysis and synthesis of signals. That is why in lesions of these zones all processes involving such a spatial analysis and ~~simultaneous~~ synthesis of separate impressions in ~~coherent~~ simultaneous coherent wholes have to be disturbed. The most important - and novel - fact is that not only ~~[illegible]~~ perceptual, but as well several forms of conceptual elaboration of information require that spatial factor: how could we make a simple distruction of ~~two~~ 86 numerals digits if we couldn't apply this process on an inner quasi-spatial field and if we couldn't use such inner relations as „towards the right" (addition) or „towards the left" ~~[illegible]~~ (diminution) The same ~~[illegible]~~ can be said about the complex logico-grammatical relations: how could we use complex relational forms of grammar if the coding in an inner quasi-relational ~~[illegible]~~ schemes would be impossible?

A careful analysis of the syndrome ~~of~~ resulting from a ~~circumscribed~~ local brain injury shows that all processes disturbed by ~~f~~ such lesion have a common factor, and this ~~is of a~~ fact ~~is of~~ - as we already said - is of a high value both for practical ~~purposes of the clinical new~~ local diagnostics and for theoretical psychological conclusion.

A separate symptom of a local brain lesion ~~has~~ is of an heuristic value but has not yet a sufficiant reliability. Only ~~a collection of na~~ a group of symptoms having a common factor make the local diagnostics highly reliable; that is why ~~a good and~~ sophisticated ~~a~~ neuropsychological study of a case with local brain injury can make good predictions and results in ~~a~~ highly reliable ~~a~~ local diagnostics.

At the same time ~~the~~ the theoretical significance of ~~this~~ the analysis ~~has~~ has not to be underestimated. In describing of disturbances of a whole complex of processes resulting from a circumscribed local brain lesion, and in studying most carefully the ~~by common~~ features of these disturbances we become able to conclude what are the common factors of different psychological processes and thus to ~~make an important step towards the study a~~ improve our knowledge about their inner ~~psychological structure~~ psychophysiological

But that is just what one of the most important of ~~psych~~ modern psychology - the factor analysis tried to do with ~~a bat~~ studies of broad number of cases and with application of ~~a series~~ battery of ~~matte~~ mathematical methods. That is why we could say that neuropsychological analysis of local brain injuries can be used as one of the direct ways towards a factor analysis of several ~~psychological~~ behavioral processes, helping to find common features in apparently different, and differences in apparently similar psychological functions.

And that is a ~~rel~~ really important significance of Neuropsychology for Psychological Sciences.

We are close to the end of our discussion and we can make only a few - but important - conclusions.

~~We made~~ In following the ways of the modern Neuropsychology we made a ~~very ins~~ highly instructive journey.

We learned that every task of applied psychology can be efficient only if it ~~has~~ based on a good theoretical ground. But we learned as well that every ~~practical~~ good practical work can ~~result in~~ open very important ~~theoretical conclusions~~ ways for theoretical problems.

That means that there is not a clearcut frontier dividing applied and general psychology, and that a succes of a work can be provided only by a close interrelation of both fields of the psychological science.

Fig. 1. Принципиал. схема стола (схема перед. и задн.)

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