BRAIN RESEARCH
AND
HUMAN BEHAVIOR

A.R.Luria

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The few latest decades of this century were a period of a brillant progress of the Brain Research.

What did we really known about the functional units of the brain 40-50 years ago?

Let us return mentally to the situation in our science in the twenties of our century. At that time we already had a very fine descriptions of the structural organization both of the Brain Cortex, and the outstanding studies of Ramon-y-Cajal and the Vogts made a fundamental contribution to our knowledge. But our information about the functional organization of the Brain was extremely poor, and the physiological approach to its processes were limited to the basic laws of integrative functions of the Reflex Arc and that of Conditional Reflex.

In recent years the situation radically changed.

Thanks to a brillant crowd of outstanding scholars - Lord Adrian and Sir Eccles, Fessard and Jasper - some of them are fortunately present at our Conference - our information on the Basic mechanisms of the Brain mechanisms has been enormously enriched. Basic neurophysiological data on several Brain systems were discovered; a great wealth of information about the Basic actions of single neurones was obtained; outstanding discoveries of the transmission of excitation in synapses were made, and important data ob biochemical bases of memory traces were described.

A brillant progress in the analysis of some Basic Brain mechanisms is doubtless.

But what do we know about the Nervous substratum of Human Behavior? What can Brain Research tell us about the Basic mechanisms

of our perception and cognition, attention and memory, speech and conceptual thinking, organization of Human intentions and actions?

A centuty ago our knowledge about the Brain as a substratum of Behavior was near to the zero level, and our information about the Behavioral functions of the Brain were much closer to Mythology than to Science.

A few centuries ago philosophers were sure that the seat of
Fig.1. our mental faculties is to be sought for in the three ventricles of the Brain, the first of them being the bearer of perception, the second - of intellectual properties, the third - of memory.

As far back as the beginning of the 19th century, a limited group of scholars accepted the ideas of Gall - a brillant anatomist, but a man with too vivid imagination - who supposed that
Fig.2. separate mental faculties - sometimes very complicated - were the result of activity of circumscribed foci of the Cortex.

The time of phantastic ideas has passed rather quickly, but the style of Brain Mythology remained for a very long period - even up to our time. A series of outstanding Psychiatrists made important description of patients with local Brain lesions, - but their interpretations remained close to those of the old Brain Mythology.

When K.Kleist - the famous German psychiatrist described his patients - he made an important contribution to our clinical knowledge; but when he supposed that some circumscribed areas of the
Fig.3. Brain Cortex were the seat of "the understanding of grammatical structures" or of "Active thought" or "the Social Ego" - he still followed the old tradition. May I mention the fact, that in some modern American handbooks of Neurology (for example in that of Nielsen) - perception of animate beings is supposed to be a

function of one part of parieto-occipital lobe, and the perception of inanimate objects - function of another?...

A witty philosopher said once that the weight of great ideas can be measured by the length of time they blocked the development of contemporary Science. If so - the idea of an immediate localization of complex mental processes in circumscribed areas of the Brain was really a great idea!...

2.

The progress of scientific psychology brought a radical change in our understanding of the inner structure of psychological processes.

Now we no longer suppose psychological functions are indivisible inborn faculties.

After a series of important studies of such outstanding Russian scholars as P.K.Anokhin and N.S.Bernstein it became clear that even relatively simple physiological processes - such as respiration or movements are really complicated self regulating functional systems, which achieve the final invariant goals via highly variable executive mechanisms, and when one of them is blocked - new constellations of executive mechanisms lead to the same final effect. The same can be said about complex psychological functions, carefully studied by professor L.S.Vygotski, one of the leading figures of modern Russian Psychology. Now we know, that such processes as perception or voluntary action, active memory or abstract thought - are really complicated functional systems, social by origin, indirect in structure and consciously self regulated in function, - and their construction is well described by psychologists.

That leads to a radical change in our approach to the problem of their Brain organization. Now we don't even try to find separate areas of the Brain where these complex psychological processes are "localized". Our goal is now different: we shall try to answer another question: how are these functional systems realized by dynamic constellations of cerebral zones, and what every zone contributes to the realisation of every functional system?

That is quite a different approach to the problem of Cerebral Organization of Human Behavior, - and careful studies of patients with local Brain lesions - which remain the basic source of our knowledge - is now made in different ways and bring us to very different results.

3.

It is a well known fact that the Brain as a complex self regulating system consists at least of three basic functional Units or Blocks. The first Block is rather well known after the brillant researches of Magoun, Moruzzi, Jasper and Penfield. We may designate this Block as a general, unspecific Energy Supply or a Block of Homeosthasis and Vigilance. It includes the upper Brain Stem, Reticular Formation and the older, limbic systems of the hemispheres. When one part of this system is destroyed - nothing in the input of information from the external world is disturbed, but the level of Wakefulness is lowered, memory traces become instable, and the normal selectivity of nervous processes suffer.

I hope you remember one of the basic laws of the flow of the nervous processes formulated by Pavlov. The normal Brain responds to strong or significant stimuli by strong dominant reactions, while weak or insignificant stimuli result in weak responses which are

easily suppressed. This provides a high selectivity of the nervous processes in animal and man. Let us remember how selective is the course of our thinking and how precise the programs of our actions are!...

Now all this is changed when the tone of the cortex is lowered and when derangements of the first Block result in a lowered, inhibitory state of the cortex. Pavlov studied these changes very carefully and his description of so called "inhibitory phazes" are among the best fractions of his work; in these lowered, drowsy states of the cortex strong or significant stimuli become equal to weak or insignificant ones, and both begin to evoke the same responses; and when the inhibitory state of the cortex is intensified - weak stimuli begin to evoke even stronger reactions than the significant ones. It is cleare that such a state of the cortex result in a disturbance of selective organization of psychological processes. Let us remember for exemple the strange course of our associations in a drowsy state, when disordered, uncontrolled thoughts and memory infiltrate our mind. It is very possible that a physiological approach to the structure of our dreams may result in some unexpected discoveries...

In the last few years we could study a series of patients with deep Mesial Brain tumors and with acute hemorrages in the mesial parts of the hemispheres; and we could observe how pronounced was the instability of their attention, reduction of organized memory traces and the loss of selectivity of their associations! A few months ago we published jointly with our friend Dr.Macdonald Critchley a description of a case where a tumor of mesial parts of the Brain resulted in a marked disturbance of selective mental processes, and since this first attempt - new series of such patients

were studied. The first Block, regulating the vigilance of the cortex and the selectivity of the nervous processes, participate in every psychological activity; the importance of this Block for organized Human Behavior is now clear, and we shall no longer dwell here upon its functions.

The Second Block of the Brain has been much more investigated and its role in the functional organization of behavior is immesurably more known. We may designate it as a Block of input, coding and conservation of information received from the external world. The basic principles of the organization of this Second Block of the Brain - which includes posterior parts of the hemispheres - are very different from those of the first Block. This Block doesn't deal with excitations coming from the internal spheres of the organism, nor does it regulate levels of vigilance and homeosthasis, and its apparatus are not organized in a continuous nervous net. It receives signals from the external world and is responsible for their analysis and coding. It is composed by a complex structure of separate neurons and their connexions, and as it become clear during last decades - the Basic work of those elements splitting the information in millions of separate attributes and their synthesis in dynamic structures - is due to the wonderful capacity of single neurones to react to very specialized qualities which form the components of geometrical figures, colours, pitches etc. This remarcable specialization described in now classical works of Hubel and Wiesel, Jung and others seems to be one of the most important discoveries of modern science.

There is a second feature which differs the work of the Second Block from the first one, and that is a high specificity of topographical parts of this Block.

The occipital parts of the Brain cortex which enter this Block are responsible for input and coding of visual stimuli and don't react to acoustic or tactile information, while temporal (acoustic) or parietal (tactile) parts of the cortex remain indifferent to the optic stimuli. That is why the injuries of the temporal zones resulting in disorganization of acoustic information don't bring any disturbances of visual or tactual analysis, - and only during the last years we could prove that injuries to the left temporal lobe resulting in disturbances of verbal-acoustic memory do not disturb visual or kinesthetic memory traces, - and that this picture changes when the focus of the lesion moves to the caudal (occipital) or to the upper (parietal) parts of the Brain.

This highly specialized principle of work of sensory (or extrinsic) zones of the cortex changes if we move to the more complex - intrinsic zones which are well known as "secondary" or "tertiary" areas of the cortex.

The clinical experiences show that these zones have an integrative function, organizing the information obtained by the primary or extrinsic zones in more complex, integral structures, providing a simultaneous organization of separate elements of information. The outstanding contribution of such neurologists as Henry Head and Otto Pötzl, Denny Brown and Critchley, Zangwill and Hécaen, as well as some of our studies, showed that injuries to the parieto-occipital parts of the cortex - which are the clearest example of such tertiary, intrinsic areas - don't bring any disturbances of sensory input, but result in marked deterioration of "simultaneous perception", in evaluation of spatial relations, in an inability to "include separate stimuli into a coherent whole".

We had studied very carefully the disturbances of behavioral

processes after lesions of this zone of the Cortex, and we could show how important is the integration of separate impressions into simultaneous structures for complex forms of cognitive processes.

I have discussed this problem in a series of publications on Higher Cortical Functions in Man, - and I shall not go here in further details.

I shall mention only in brief the third Basic Block of the Brain although I spent more that thirty years to study its functions.

The anterior parts of the Brain, and especially the Frontal Lobes play an important role in the organization of the self-regulating systems of Human Behavior. One hardly can name a higher mental process which would be independent of the Frontal Lobes; they can be rightfully considered as the principal apparatus of programming, regulation and control of Human Behavior.

More then 50 years ago Bianchi advanced the idea that they are one of the Basic mechanisms of integration of Behavior, while Bekhterev formulated their function as "evaluation of outcome one's own actions and the organization of the behavior according to one's own benefit" (1907). During the last decades my friends P.K.Anokhin in the USSR and K.Pribram in the USA developed a theory formulating the role played by the Frontal Lobes in mapping the intentions, in programming of behavior and in matching the outcomes of behavior with initial intentions and plans. They both observed marked deterioration of purposeful behavior of animals deprived of Frontal Lobes, and empasized their role in the mechanism Anokhin designated as the "Acceptors of outcome of Actions". I can only join them in their ideas, and in a series of publications - especially in my last volume edited jointly with Dr.E.D.Homskaya on the Frontal Lobes and Regulation of Psychological Processes I tried to summarize our

Basic findings concerning the role this Block plays in Human Behavior. No loss of sensory input, movements, perception or speech is observed in patients with massive lesions of the Frontal Lobes, - and that is why some Neurologists supposed them to be "a luxury of the Brain" deprived of any significant function. But a careful observation of these patients can easily show, how greatly suffer their intentions, how significant is the loss of planning their Behavior according the future goals, how primitive and stimuli bound became their conduct, and how clear becomes their inability to evaluate the effects of their action and to correct their mistakes.

A careful study of the contribution of the Frontal Lobes to the organization of Human Behavior is really one of the most exciting chapter of Neuropsychology. We shall have the occasion to dwell on this problem in the latest part of our discussion.

4.

Let us now approach our Basic problem: what can Brain Research contribute to our knowledge of Human Behavior?

It is clear that our starting point will be not similar to the classical attempts to "localize" complicated mental functions in the circumscribed zones of the Brain. We shall try to find out <u>what does every unit of the Brain contribute to the complex functional systems which form the base of Behavioral processes</u>, and that will be the Basic approach of modern Neuropsychology.

Neurologists and psychiatrists who tried to "localize" complex mental functions in limited cortical areas were puzzled by two facts: The first was that a circumscribed cortical lesion resulted often in a series of very diverse symptoms; the second was that the

same function could be severely damaged in cases of very different localizations of the lesions.

These two facts - which the classical scholars prefered to neglect - have turned now in the starting points of the modern Neuropsychology.

Let us examine these two facts in greater details.

If a psychological process - perception or action, speech or thinking really presents a functional system - then it becomes obvious that it is based on a complex constellation of cerebral zones working as an organized whole, each of them contributing its own factor to the functional system. It is likewise clear that an injury of a circumscribed zone results in a disorganization of all systems including the injured factor but does not provoke any disturbance in systems which don't include it. That is why lesions of a circumscribed cortical area may result in a group of functional disturbances, and the more complex is the function of the injured zone itself - the broader is the spectrum of the deranged forms of behavior.

This fact does not explain the variety of symptoms resulting from a circumscribed Brain Lesion, but offers up new ways for a neuropsychological analysis of the behavior processes themselves.

May I dwell now on two very reliable and sometimes unexpected groups of facts?

I have already mentioned that the convexital part of the temporal lobes can be considered as central part of the acoustic analyzer, while the temporal zone of the left hemisphere (in righthanders) - as a special apparatus for analyzing the speech sounds.

After a careful examination of many hundreds of Brain wounds during World War II we found that about 95% of the subjects (right handers) with wounds in the left temporal zone showed marked difficulties in discrimination of the so called "correlative phonemes" - or verbal sounds differing only by one attribute (such as b/p, d/t) while elementary hearing remained intact. Disturbances of discrimination of phonemes was supposed to be the Basic symptom of lesions of the left temporal lobe. But such disturbance never remained an isolated symptom. Patients with severe defects in discrimination of phonemes as a rule exhibited a group of other symptoms: disturbances in the finding of words, in repeating of words or fragments, in the retention of series of words and very often - in understanding speech. The nature of these disturbances is evident: perception of words as well as finding, repetition or retention of verbal utits require a stable capacity to discriminate phonemes, - and if a subject experiences some difficulties in discrimination of such words as "dome" and "tome", "bright" and "pride" - the result is a breakdown of the understanding or repetition of these words. Simultaneously a new symptom arises - severe difficulties in writing: in the Europian languages it is impossible to write a word if the phonemes the subject have to re-code in letters become uncertain and diffuse. All these disturbances are of a specific character - they all are results of one basic defect, and it is obvious that processes which don't require phonemic analysis - such as orienting in space, geometrical concepts, counting remain undisturbed in all patients with lesions of the left temporal lobe.

Fig.4.

A very different structure of disturbances can be seen in injuries of more complex - parieto-occipital parts of the left hemisphere.

As I had already said these parts of the cortex which overlappe the central fields of visual, tactual and vestibular analyzers and which have a more complicated neuronal structure - bear a close relation to the integration of separate impressions into coherent wholes and play a decisive role in a spatially organized schemes. That is why injuries of these zones result in marked defects of orientation in space, and that fact is well known in Neurology. Particularly important is that these defects never remain isolated. Patients with disturbances of spatial schemes show, as a rule marked deterioration in a group of cognitive processes which require simultaneous synthesis and a quasi spatial orientation. Let us try to make a simple arythmetical operation mentally, for example 31-7, - and we shall see to what a considerable degree this operation depends on the existance of stable and quasi spatial inner fields and how difficult is to accomplish this operation if such schemes are disturbed.

But that is just the case in lesions of parieto-occipital parts of the left (dominant) hemisphere, and that is why in all cases of such injuries we can observe a complex of symptoms including defects of orientation in space, errors in evaluation of the Right and Left, disturbances in analyzing geometrical relations and geographical maps, and difficulties in calculation.

It should to be noted that in all cases of such injuries - severe defects of operations with complicated grammatical structures are observed, and the patients who manifest difficulties in dealing with spatial schemes or in calculation is - as a rule - unable to discriminate the differences in such relational constructions as "fathers brother" and "brothers father", "spring before summer" or "summer before spring".

A long time ago I spent a few years on studying the history of grammatical forms, - and I became sure that a careful analysis of the defects we are discussing opens new ways for a better understanding of their inner structure.

5.

What we have mentioned is only the first step of the studies of the Brain mechanisms of Human Behavior.

The next step is a careful examination of the disturbances of the same psychological functions in lesions of different parts of the Brain.

During the last two decades we studied as carefully as we could the Basic differences of the disturbances of the same psychological process such as perception or action, memorization or cognition, speech or calculation in various localization of Brain lesions; this kind of analysis became the Basic method of modern Neuropsychology.

In order to demonstrate how this approach helps to understand the inner composition of behavioral processes, I shall limit my discussion to an analysis of only one kind of activity, - and that will be the process of writing. This process is well known to everybody, but the knowledge of the psychological composition of this process remains still limited, - and we shall see how the analysis of the disturbances of the process of writing in different localization of lesions of the Brain can reveal a series of very important - and sometimes unexpected results.

What is really necessary for writing down a word or a sentence, - and which zones of the Brain Cortex take part in this process?

There was a time when neurologists considered the process of writing as a complex motor skill believing that there exists a special "writing center" in the middle part of the premotor zone of the left hemisphere. Nothing can be more erroneous that such an assumption.

In order to write down a word one must first of all single out some distinct phonemes from the flow of speech. But the system of phonemic organization is very dissimilar in different languages, and it to an Englishman "wine" and "vine" sound very different, just as to a German the words "Stadt" and "Staat", "Satt" and "Saat" (although the only difference is in the fricativeness of "v" or the length of "a"), - to a Russian whose language has no such phonemic distinctions both pairs of words are hard to discriminate. The same difficulties arise for an Englishman, German or Frenchman if they try to grasp the differences in three Russian words: "пыл" (which means "fire"), "пыль" (which means "dust") or "пил" (which means "he drunk"), because the phonemic attribute of softness doesn't exist in their languages. I could mention a series of very funny exemples of difficulties for both Russian, Englishman and Frenchman to grasp the differences of some Georgian words (as "Kari" = door and "K̇ari" = wind, "puri" = bread and "p̣uri" = oxen) or Chinesse words ("ma˥" = to buy and "ma˩" = to sell)! The work has to be done before a subject becomes able to write down a word is to analyse the flow of speech and to single out some significant phonemic attributes according the phonemic system of language. But that is just the work of the left temporal lobe which is a central device for a verbal-acoustic analyse, and that is why lesions of this zone don't only break down the phonemic analysis of verbal sounds, but result severe

Fig.5. disturbances in writing. We can see how strenuous are the efforts to analyse the phonemic structure of the words and to write it down in such patients!...

An acoustic analysis of verbal sounds is absolutely necessary but in some occasions is not sufficient for the process of writing.

One can easily remember cases when he tries to make the phonemic construction of the word more distinct and resorts to the assistence of his articulation. You ask: "How do you spell your name? B - r - a - n - d - l ?" - and you gain impression that by feeling the sounds with your tongue and lips you receive a clearer information of the phonemic structure of the name.

Some 20 years ago I was not sure whether a permanent noise of articulations with which children of the 1st grade accompany their first lessons in writing are helpful or distractive; but when one of my colleagues tried to make a special study asking one group of pupils to write and simultaneously to pronounce the words and a second - control-group to do it silently (with an open mouth) - the latter made six times as many mistakes as the former!...

But the cerebral mechanisms of the articulation does not involve the temporal lobes; they are intimately connected with the post-central, kinesthetic area of the cortex; and patients with lesions of that part of the Brain resulting in disturbances of articulations show, as a rule, marked difficulties in writing, this time - of another type - manifesting troubles in the discrimination of such phonemes as d - l - t or b - m - which sound very differently
Fig.6. but are very close in their articulation !...

A very essential fact is to be noted: a destruction of the left temporal or post-central part of the Brain result in European patient

in disturbances of writing, - but this is not the case in the Chinecse: the Chinecse hieroglyphical script which designates concepts but not sounds, doesn't require any acoustic or articulatory analysis of the words and can remain intact in lesions to these two Brain regions. Isn't that a nice example of the importance of psycholinguistic analysis for some clinical facts?...

Let us procede with our analysis. Psychological processes involved in writing are not limited to the singling out separate phonemes but go much further. In order to write down a sound one has to recode phonemes into letters or graphemes; but to make this re-coding and to preserve the graphic structure of the letter - one has to find an optic symbol corresponding to the sound and to preserve a normal spacial scheme of the graphic elements. That is why lesions of tempore-occipital and parieto-occipital parts of the left hemi-
lg.7. sphere may also result in severe disturbances of writing - this time in a different forms of difficulties in finding appropriate letters
lg.8. or of disorganisation of spatial relations of their parts. Symptoms of an optic and spatial agraphia are so clear that one can hardly forgot them.

It may be supposed that this is the end of the process of writing; but it is not so !

To write down a word one has to analyse the sequence of sounds and to preserve their successive order; one has to make a third recoding, this time of of separate acoustic images and graphic symbols in a system of successive movements. But this is again a task of other cortical areas, this time - of a constellation of accustic (temporal) and premotor zone. As observed in a long series on our studies - premotor zone play a special role in a successive integrat.

ion of movements and a injury to the anterior part of so-called "speech area" of the cortex may result in a disturbance of sequential analysis of both phonemes and graphemes; separate phonemes

Fig.9. remain preserved but strong sounds may be written down before the weak sounds, the sequence of letters in a word may be confused, - and when the lesion of the promotor zone was deep located and the normal relations of the cortical area with the Basal

Fig.10. ganglia were disturbed - uncontrolled excessive movements were observed which the patient was unable to stop and which make the writing unintelligible.

May I add that there exists even a more complicated level of the organization of the writing process - that is the regulating the writing by intentions and plans, - and that involve the participation of the Frontal Lobes! I cannot forget a patient with severe damage of the Frontal Lobes who wrote a letter to the famous Russian Neurosurgeon Dr.Burdenko "Dear Professor, I want to tell you that I want to tell you that I want to tell you..." and two pages of this letters did not go a step further!...

That conclusions can we draw from our analysis ?

It becomes clear that writing is a very complicated psychological process which includes many links and is realized by a dynamic constellation of highly specialized cortical zones acting as a functional system. Each part of this system makes its own contribution to the whole process. That is why careful study of the disturbances of this process in different localization of lesion begins to serve us as a basic method of an analysis of the inner structure of this behavioral process itself.

The analysis of an writing was only an example. The same method

- as I have already said - can be applied to a long series of behavioral forms, and I could easily show a similar kind of neuropsychological approach to the analysis of perception and memory, speech and cognitive processes. Doesn't it open new perspectives in our Basic Problem - the application of Brain Research to a scientific understanding of the inner construction of our behavior?

6.

Our discussion on Brain Research and Human Behavior would be incomplete it we limited it to analysis of some cognitive functions and to the participation of the Second Block of the Brain in the organization of the behavioral processes.

The Brain is a self-regulating system, and so is Human Behavior. We have intentions and plans; we realize some programes and we match the result of an Actions with the initial intentions in order to correct our errors.

What can Brain Research tell us concerning the mechanisms of active and self-regulated Behavior ?

Although I spent many years on studying the Frontal Lobes and their role in regulation of human behavior, - I shall confine myself only to very brief summary of our data.

There was a time when we practically knew nothing about the role of the Frontal Lobes in the organization of Behavior. It is a well known fact - and I have already mentioned it - that a patient with severe lesion of the Frontal Lobes preserves his sensations and movements and no defects in his speech and sometimes even in the formal logical structures are observed. That is why some neurologists supposed Frontal Lobes as a "luxury" of the Brain. But if

we examine the behavior of those patients closely our impression will change and it will become clear how significant the impact of Frontal Lobes is in every complex self-regulated Behavior.

To start some purposeful action one has to formulate the intention and to retain the decision; this decision has to be recoded in the form of a program, and this program has to play the decisive role in a series of selective successive operation; every outcome of the action has to be matched with the preliminary intention, and if a mismatch takes place - the subject has to start anew the active search for the solution of the problem and the whole series of actions ~~are~~ is started again.

No such complicated structure of Behavior exist in patients with severe lesions of the Frontal Lobes.

During the last years some very important facts were discovered simultaneously by outstanding scholars of different countries.

Dr.Grey Walter in England showed that every intention - for exemple expectation of signals - evokes a special kind of slow potentials in the Frontal Lobes of the subject - he called them
Fig.11. "Expectancy waves". At the same time Dr.M.Livanov of Moscow showed that whenever the subject starts a complex intellectual act - there appears a great number of sinchroneously working active
Fig.12. points in the Frontal Lobes of the Brain. We may assume that the activation of the Frontal Lobes is really involved in every consciciseness activity and that it plays a decisive role in formulating and retention of our intentions. These important facts are corroborated in some research carrieres out in the latest years in our laboratory.

My friend Dr.E.N.Sokolov found that each new stimulus evokes

a series of vegetative and electrophysilogical reactions which he regards as components of the Orienting Reflex. These reactions disappear after the subject becomes habituated to the stimuli, but they appear anew when he is asked to pay attention to the stimuli, to expect some changes in them, to count them etc.

This kind of activation of Behavior via a verbal instruction can be observed in all normal subjects as well as in the majority of patients with injuries to the posterior parts of the Brain; but as it was shown by my collaborator Dr.E.D.Homskaya - this stabilization of active state of Behavior is not observed in patients with the lesions of the Frontal Lobes, - and predominantly in lesions of their mesial parts.

Here is only one example: a normal subject is given a series of indifferent sounds; each of them provokes a constriction of vessels which is a vegetative component of the orienting reflex. After a while the subject is habituated to those sounds and they don't more provoke any vascular reactions. But when an instruction
Fig.13. is given to count these stimuli or to expect their change - the vegetative components of the orienting reflex are stabilized. The same is seen in patients with lesions of posterior parts of the Brain; but a very different picture can be observed in patients with lesions of the Frontal Lobes: the instruction doesn't result
Fig.14. here in an arousal of these reactions.

That means that the Frontal Lobes play a significant role in the highest forms of regulation of vigilance, and that the organization of stable intentions is impossible when the Frontal Lobes are distroyed.

This basic fact results in very important alterations of the

complex structures of Behavior in patients with lesions of the Frontal Lobes.

If those patients become unable to preserve standing vigilance - their intentions and inner plans of Behavior became unstable; they become unable to establish appropriate programs of Behavior, to match the effects of their actions with initial decisions and to control the flow of their own activity. That is why patients with severe injuries of the Frontal Lobes cease to subordinate their own conduct to the future goals. Their Behavior becomes stimulus-bound and concrete and their programmed actions are replaced by inert stereotypes which make their Behavior senseless.

To demonstrate such massive disturbances of Behavior I shall cite only a few exemples.

A patient with massive lesion of the Frontal Lobe is given the task to draw a circle and than - a line. He first drow a circle and then without displacing his hand - rectangle (similar
Fig.15. to the closed figure of a circle)... and unexpected to me - added a sentance; "Entrance forbidden". Can you guess a what the patient's profession formerly was?

Severe lesions to the Frontal Lobes don't result only in disturbed fulfillment of the given programs. They lead to a break-down of any independent elaboration of such programs or plans of Behavior.

May I show you that dramatic changes of Behavior by one more and last exemple ?

The recent years have brought us a new amount of information concerning some basic mechanisms of our perceptive activity. It became clear that even a simple perception is by no means a

passive reflection of external stimuli. Jerome Bruner, one of the most gifted modern psychologists has shown that perception is rather an active process of selection and coding of information which the subject obtains.

Now we can analyse this process by studying the eye movements during the subjects observation of an image. One can easily do it by fastening a small mirror to the sclera of the subject and by registrating his eye movements on a sensible paper. These experiments conducted by a very able Russian scholar Dr.A.L.Yarbuss showed that in every perception a series of the searching eye movements singling out significant attributes of an object
Fig.16. are involved and that final information concerning the object results from such searching activity.

The same may be seen during the subjects observation of
Fig.17. complex thematic pictures, and it is very important that each change of instruction given to the subject radically changes the structure of his gaze.

That complex structure of the active search for information is essential for the cognitive processes in a normal subject
Fig.18. just as in patients with lesions of the posterior parts of the Brain whose spatial orientation can be disturbed but who preserve their active searching type of cognitive Behavior.

No such active structure of perception exists in patients with massive lesions of the Frontal Lobes, and recording of their eye movements during the observation of complex thematic pictures does not show any signs of active search as well as no
Fig.19. changes in their gaze following different instructions. It is obvious that such chaotic, perseverative eye movements which

have lost the role of servo-mechanisms of cognition are symptoms of a breakdown of the most complicated forms of our active cognitive Behavior and that the Frontal Lobes play a decisive role in its organization.

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And that is the end of my discussion.

I clearly realise that I was unable to cover the broad field of a new discipline - Neuropsychology which emerged during the last decades and which has developed now into an important branch of science. But I have done my best trying to give you only some ideas of that branch and to show you the broad perspectives which opens up for our Basic Problem - the significance of Brain Research for Human Behavior.