

## PSYCHOLOGY AND LOCALIZATION OF FUNCTIONS\*

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1.

A PSYCHOLOGICAL approach towards the problem of localization of functions in the brain is justified and productive. At every step the leading ideas of contemporary psychology have had a decisive influence on the basic approaches to the localization of mental functions in the human brain. We can use as examples—the influence of the associationistic or atomistic psychology, Gestalt Psychology and recent modern approaches to integrative conceptions of localization of functions.

The problem of localization is in its essence the problem of relation of structural and functional units in brain activities. That is why the problem of *what* can be localized is not at all irrelevant to the problem of *how* it can be localized in the brain.

2.

The most advanced of contemporary conceptions of the localization of functions could efficiently overcome the basic mistakes of the classical approach to this problem; but they are unable to arrive at an adequate solution of the problem because of the lack of structural-psychological analysis of the functions they try to localize.

This lack of an adequate system of psychological analysis of the functions localized in the brain is now one of the most significant obstacles in the development of the theory of functional localization which made a marked progress due to the progress of modern histology, cytoarchitectonics and clinical neurology.

This obstacle is especially seen in the attempts to solve the problem of localization in specifically-human areas of the brain.

It is easily seen how insufficient is the modern holistic approach to this problem and the idea of "the brain as a whole". It is easy to see that the kind of a functional analysis based on Gestalt Psychology, appearing to be very productive in the early critical part of the work (overcoming of the atomistic approach) proves as unsatisfactory in the second part of the same task. These ideas proved to be unable to make any progressive step beyond the scheme of "brain as a whole" which we mentioned.

The holistic (Gestalt) psychology, which is the basis of some modern approaches, does not allow the overcoming of the idea of two basic functions of every zone of the brain: one specific (a specific kind of mental activity), and another unspecific (included in every mental process). The ideas of K. Goldstein ("structural" vs. "background") or K. S. Lashley (specific and unspecific functions of the visual cortex) can serve as an example of such approach. Thus this approach becomes a combination of the old classical ideas of a

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strict localization of functions in circumscribed parts of the brain, and the “modern” de-localistic ideas denying this strict localization and using the concepts of “the brain as a whole” and the conceptions of equivalence of all parts of the brain.

It is easily seen that this approach is unable to overcome both extreme ideas and includes inadequacies of both “old” and “new” conceptions—that of the strict localization and the holistic approach.

This inability to overcome old contradictions can be seen especially clearly in the problem of localization of *higher psychological functions* which are connected with the specifically-human parts of the brain (frontal and parietal). In analysing this problem scholars are forced to overcome the limits of the “holistic” approach and to introduce new psychological concepts (“abstract attitude” of K. Goldstein, “symbolic function” of Henry Head, “categorical perception” of Otto Pötzl, etc.).

But it has to be noted that these new psychological concepts are as a rule reduced to the same elementary aspects of structural approach (“basic function” of K. Goldstein, “Structurisation” of O. Pötzl, etc.) or, in some cases, are treated as some kind of basic metaphysical entities (as it was in some speculations of H. Head). Thus the “modern” ideas of localization don’t go beyond the vicious circle of Gestalt psychology and are oscillating between the poles of the two extremes—naturalism and spiritualism.

### 3.

An adequate approach to the localization of functions can be built on the basis of a *historical theory of the higher psychological functions*, with the basic idea that the higher mental processes are *meaningful functional systems*. The leading assumptions of this approach are:

- (a) the assumption of plastic, changeable interfunctional relations;
- (b) the assumption of complex dynamic systems which have to be considered as the result of integration of elementary functions; and
- (c) the assumption of a categorical reflexion of reality in the human mind.

All these basic assumptions reflect the most important features of man’s psychological processes. They are an important example of the dialectic leaps in transition from perception to conceptual cognition, which is as basic as the transition from the inorganic to the organic forms of existence. Using these assumptions as basic hypotheses in our work we come to three basic ideas underlying our approach to the problem of localization. These ideas can be considered as important working hypotheses, adequate to explain important clinical facts, and providing a basis for further experimental investigations.

### 4.

The *first* assumption deals with the problem of the functional evaluation of the *whole* and *the part* in the activity of the brain.

The analysis of aphasic, agnostic and apractic disorders shows that the kind of approach to the relation of the function of the whole and of the parts proposed by K. Goldstein and K. S. Lashley is insufficient. The assumption of a double (specific and unspecific) function of every brain zone is unable to explain the whole complex of data in the disturbances mentioned.

Investigations lead to an opposite solution of the problem.

They show that any specific function is never based on an activity of a limited zone. It is a product of an integral activity of a very differentiated, hierarchically constructed complex of separate zones. They show that the function of "the brain as a whole", providing the "background" for every activity, is not at all a result of a simple cooperation of all other parts of the brain; it can be understood only as a product of hierarchically organized functions of separate zones of the brain, which don't take an immediate part in the construction of the "figure". Thus, both the functions of the "whole" and the functions of the "part" cannot be described as some simple "function" which in one case is a result of a homogeneous "brain as a whole", and, in the second case a homogeneous function of a specialized "center". Articulation and unity, integration and differentiation of isolated zones can be found both in functions of the "whole" and that of the "parts". Differentiation and integration are not contradictory, they are interconnected and included in the same process. The most important fact is that *for different functions we can assume different kinds of interareal relationship*. At least it can be said that relations of function of the part and function of the whole is different in cases when higher psychological functions are considered as a "figure" and lower functions as a "background", and in the opposite cases when the "lower functions" represent a "figure" and the "higher psychological functions" a "background". That assumption is able to provide a new explanation of the cortical organization of automatized and disautomatized processes as well as of the different level of organization of functions, cases, where different relations of cortical systems can be assumed.

## 5.

Experimental investigations brought us to several important conclusions.

(1) In every focal lesion (aphasia, agnosia, apraxia), functions which are not connected with the area destroyed, show signs of a specific kind of disturbances, and never suffer equally. Thus, the assumption of equivalence of different parts of the brain in relation to the unspecific functions is a mistake.

(2) The same function, not connected directly with destroyed area suffers very distinctly in cases of different localization of the destroyed zone, and never shows the same symptoms in cases of different localization of the injury. Thus, the idea of a certain equivalence of different zones of the brain concerning the functional "background" seems to be a mistake.

These two statements result in a conclusion that the function of the "whole" is an integration of a complex, differentiated and hierarchically organized dynamic interrelation of separate zones.

Another series of experiments led us to the next two conclusions:

(1) Lesion of a certain part of the brain immediately connected with a special (sensory, motor or mnesic) component of a complex function (speech) result in a disturbance of this function as a whole, with all its components included; but the disturbances of all components (or sides) of the function are uneven. That proves that the activity of such a complex psychological system requires not only a combination of specific areas, but also a *system of zones* which are functioning as a unit and which take part in the formation of every partial aspect of the function.

(2) Every complex function not immediately depending on the disturbed area suffers in a *very specific mode*; that is not a result of a disturbance of the homogeneous "background" but has to be described as a specific "figure" depending on the lesion of areas, which provide some features important for the realization of this function.

That proves once more that the normal activity of a complex system is guaranteed by the integrity of a certain complex of zones which includes more than just zones taking an immediate part in the realization of this psychological system.

These two statements lead to the conclusion that both the function of the "parts" and the function of the "whole" are organized as an integrative activity of interrelated foci.

## 6.

Whereas the structural-localistic analysis made a marked contribution by singling out certain systems and describing complex inter-relation of separate zones, the *functional* analysis remained in a worse state. The most outstanding investigators studying both the higher and the lower functions had to use vague psychological concepts. Very often they used to explain the disturbance of higher areas of the brain (for example that of Pötzl's "weitere Seesphäre") in the terms of lower areas of the brain (for example that of Pötzl's "engere Seesphäre"). The concepts of holistic (Gestalt) psychology used by these authors are inadequate for the explanation of the complex hierarchy and inter-relation of different foci which is basic for the higher forms of the cortical activities. That is why the investigations mentioned do not permit the overcoming of purely descriptive terms (such as "primitive-complex", "shorter-longer", etc.) and have no other results than reducing the relation of the specific functions of the higher areas to the lower, to "inhibition" or "excitation". Irrespective of their attitudes they ignore all specific and new features which these higher areas introduce into brain activity. According to these concepts, higher "centers" can only inhibit or sensitize the activity of the lower centers being unable to create new principles of brain activity.

Our investigation allows a contrary assumption. We are sure that the most important function of every new interrelation of the zones provides a *new form of functional activity*, which cannot be reduced only to inhibition or excitation of the activity of the lower "centers". The basic element in the specific function of every higher zone is a *new modus operandi of mental processes*.

## 7.

The *second* of the theoretical conceptions we came to as a result of our studies is that of the *relation of functional and structural units in disturbances occurring in the child's early development and in the dissolution of functions of the adult brain by focal lesions*. A comparative study of symptoms resulting from a local lesion on the early changes of development and in the mature brain brought us to the conclusion that *identical syndromes can be in both cases a result of different localization of lesions*, and *vice versa that lesions with identical localization in children and in adults result in very different disorders*.

We can formulate a law for these basic differences. In disturbances occurring in early stages of development resulting from a local brain lesion it is the nearest *higher* center which suffers the most, whereas the nearest lower center suffers less. In local brain lesions to a mature brain it is the nearest *lower* center which functionally depends on the higher zone which suffers primarily, whereas the nearest higher center, which became independent in the course of development and which functions at a regulatory higher level, suffers less.

We find the proof of this law in all cases of aphasia and agnosia occurring in different stages of development, in cases of the results of epidemic encephalitis in children and adults as well as in oligophrenic state resulting from different localization of brain lesions.

An explanation of these data can be found in the basic fact that *complex inter-relations of different cortical zones is a result of development*, and that *different inter-relations exist at early and late stages of the development* of a human being. "Lower" levels are basic for the development of the "higher" levels, and it can be easily proved at the early stages of development. But, as a result of the general law of a shifting of functions towards the highest level, these "higher" levels become independent in the cause of further ontogenetic development. Development goes upward, dissolution downward.

Some additional proofs come from the observation of *compensatory mechanisms* in cases of local defects. In the mature brain these compensatory functions are performed by the higher "centers", in the earlier stages of development, by the "centers" lower than the injured zone. That is why a comparative study of development and dissolution is one of the most fruitful methods of the analysis of localization of function in general, and especially of the problem of so-called chronogenic localization.

## 8.

The *last* of the three theoretical conceptions we came to as a result of our research deals with *some features of localization of functions in specifically-human parts of the brain*.

A careful study of aphasia, agnosia and apraxia leads to the conclusion that "*extra-cerebral*" connections play an important role in the localization of functions in these areas.\*

These "extra cerebral" connections are basic for the functioning of speech, cognition and action in the normal person, and their disturbances result in the syndromes mentioned above.

We came to this conclusion after a series of observations of the course of development of higher forms of psychological processes. These observations showed that in the first stages all these functions are intimately connected with external activities, and only in the further steps of development do they become "interiorized" taking the shape of "inner mental activities". The same can be seen in the observation of the cause of compensation of functions disturbed by local brain injuries. It was seen that an "exteriorization" of the functions and their connection with some external objects as instruments is one of the most efficient ways for their compensation.

## 9.

The system of psychological analysis we use requires as a basis a radical change of the whole methodology of the psychological experiments.

This change includes two principal points:

(1) We have to change analysis (or reduction) of the complex whole into *elements* (which lose the quality of the whole) to a new kind of analysis of the complex whole to *units* which preserve qualities of the whole and which allow no further reduction.

(2) We have to change our analysis by reduction of the whole activity to isolated "functions" and "structures" to a new kind of analysis of the complex whole into *systems* and *inter-functional relations*. We have to select these inter-functional relations which are basic for the kind of activity we are studying.

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\* L. S. Vygotsky mentioned in his psychological works that using external tools and signs as instruments of organization of psychological processes is one of the most important features of human behavior. Including of these external tools and signs in the structure of psychological processes was called by Vygotsky an "extra-cerebral" kind of organization (A.R.L.).

In our clinical psychological studies this method allows us:

(a) to explain by one principle all positive and negative symptoms of the pathological states;

(b) to find the unitary picture which includes all symptoms which sometimes seem to be very distinct; and

(c) to outline a path leading from a single circumscribed symptom to a specific change of the whole personality and its mode of life. There are good reason to suppose that there are different kinds of localization of functions in animal and man, and that in both cases the problem of localization of functions has to be solved differently. That is why no direct transfer of data and laws from animal experiments with extirpation of parts of the brain to clinical analysis of results of brain lesions is possible, and attempts to do it (K. S. Lashley) lead to mistakes.

The theory of evolution of behavioral traits in animals by “pure” and “mixed” lines, proposed by the late Russian biologist W. A. Wagner, indicates that the specifically-human functions can hardly be observed in animals, and that the human brain works on the basis of a new principle of functional localization thanks to which it becomes a Human Brain, an organ of Man’s Conscious Life.