CHAPTER XXII

ON ‘INHIBITION’

. . . “destructive lesions never cause positive effects, but induce a negative condition which permits positive symptoms to appear,” has become one of the hall-marks of English neurology. (212) H. HEAD

Excitation rather than inhibition is important in correlation because from what has been said it appears that so far as known inhibition is not transmitted as such. The existence of inhibitory nervous correlation is of course a familiar fact, but in such cases the inhibitory effect is apparently produced, not by transmission of an inhibitory change, but by transmission of an excitation and the mechanism of the final inhibitory effect is still obscure. (92) CHARLES M. CHILD

But since inhibition is not a static condition but a mode of action, the mechanism of the total pattern must be regarded as participating in every local reflex. (107) G. E. COGHILL

It is highly probable that excitation and inhibition, the two functions of the nerve cell which are so intimately interwoven and which so constantly supersede each other, may, fundamentally, represent only different phases of one and the same physico-chemical process. (394) I. P. PAVLOV

The term ‘unconditional reflex’ applies only under ‘normal’ or ‘natural’ conditions, as we know that different drugs, such as ether, which alter the conductivity of nervous tissue. , can also alter its irritability. Similarly, with conditional reactions, the introduction of *degrees* of conditionality becomes an important ∞-valued structural refinement of language, depending on, and introducing explicitly or by implication, the number of factors, the degrees of freedom. , which are observed empirically, and so should have a linguistic and semantic parallel.

If we disregard, for instance, the possibility of the use of a drug. , then the ‘unconditional’ reactions are largely unconditional. The ‘conditional reflexes, in animals are a much subtler form of adjustment to many more factors, and if we call them ‘conditional of lower orders’ we cover structurally their limited conditionality, which with higher animals is considerable. For example, a fly in the laboratory might disturb the reactions, but merely ‘intellectual’ interference would be ineffective. And, finally, the ‘conditional reactions of higher orders’ in man involve still more factors, introduce more and new complexities, and necessitate that the human reactions should be *fully conditional,* requiring ∞-valued semantics. At present, this is an exceptional occurrence, although the potentiality for such *full* conditionality is present in the majority of us.

The mechanism of the unconditional reaction is, under ordinary circumstances, almost automatic. It is evolved on the background of general protoplasmic characteristics, combined with structural polarity, symmetry. , and is not efficient enough for the survival of higher organisms.

Under more complex conditions, the adjustment for survival must be more flexible: a similar direct stimulation must, under different conditions, result in different reactions, or different stimuli, under other conditions, produce similar reactions, resulting, ultimately, not only in direct responses to stimuli, but also in the equally important holding in abeyance of the reaction, or even the abolishing of it. Let us assume that the direct response of a cat to a mouse would be clawing and chewing. If that given cat would just claw and chew when the mouse was some distance away, I am afraid such a cat would soon starve, for such an immediate response would not be a survival response, and this characteristic could not become hereditary. The cats which have survived and perpetuated their characteristics are, as a rule, different. When they see, hear, or smell the mouse at a distance, they flatten out, keep still, crouch. , and get ready, until they are in such a position that a jump will procure the victim, and not merely frighten it away.

We see that, under more complex conditions, the nervous mechanism must produce not only direct responses to the stimuli but also equally important delays and temporal or permanent abolishments of these direct responses to stimuli.

Hitherto, we have analysed the simplest reactions of a positive character in which a stimulus produces a direct and obvious response; e.g., the showing of the food or the ringing of the bell results in an excitation in the nervous system and the secretion from the salivary glands. We are, however, acquainted with another type of fundamental nervous activity of equal importance. For instance, in experimenting with the positive reactions, we must be careful not to introduce any extra stimuli, as any new stimulus immediately excites an investigatory reaction, and the alimentary conditional reaction becomes temporarily abolished. From our personal experience, we know a large number of stimuli which have some such hindering effect on our respiration, circulation, locomotion. , which we describe as ‘paralysed with fear’, ‘speechless with rage’, ‘struck dumb’, ‘stupefied with pain’,. The diminution, or deviation, or the lack of some function or response on the nervous level is usually called ‘inhibition’.

The term ‘inhibition’ is structurally a profoundly unsatisfactory and a misleading psycho-logical term, and should be *completely* abandoned in physiology and neurology, although it could be retained in psycho-logics and psychiatry. This term is in general use, and the suggestion of abandoning a term in general use is always hard to accept. Therefore, it will be well to analyse it in some detail. In this case, it does not matter if the positive suggestion of a new term or terms is structurally acceptable; the analysis of the term ‘inhibition’ shows clearly that it has false to fact implications, and so should be rejected in neurology in any case.

This term is a favorite word in ecclesiastical and legal literature, and means, in the main, to forbid, to prohibit, to hinder, to restrain. It is a psycho-logical term; it implies anthropomorphic ‘free will’ and ‘authority’ notions perfectly unfit for *neurological* use. It is not an exaggeration to say that the structural implications of this term underlie the older animalistic prohibitive and punitive education, legal and ecclesiastical tendencies, which, in 1933, are known to be not only in a larger sense inoperative, but positively harmful. On the human level, this word is, perhaps, responsible for the fact that so much about our educational and social methods is uncertain and often harmful. Education is a process of building conditional and *s.r* of different orders. If the *neurological* terms dealing with conditional reactions are structurally unsatisfactory, our speculations which are carried on in these terms must involve these false implications. When the empirical results are unsatisfactory, as they must be, because of wrong structure of the arguments, and a scrutiny of our argumentation shows them to be correctly following the structural implications of the language used, then we usually blame ‘human nature’, which is a very unintelligent excuse, indeed.

The implications of the term ‘inhibition’ become a guidance for our conduct; we repress and, in consequence, breed un-sanity and maladjustment. On animal level, ‘repression’ is workable, but, on human levels, we need a subtler regulative mechanism, in accordance with the structure of the *human* nervous system, and this is found in the fuller conditionality of reactions, based upon consciousness of abstracting, and involving, of course, affective components, semantic factors of evaluation which regulate human impulses without the animalistic repression. In humans, the ‘inhibited’, repressed impulses *often remain as internal excitatory factors;* they are not eliminated by some ‘supernatural’ hocus-pocus, but remain active, sometimes very active, semantic sources of internal excitation, resulting in conflicts which generally have pathological results.

We are usually told that ‘inhibition’ plays an important role in conditional reactions. With the introduction of the *degrees of* conditionality, the importance of the possibility of altering, delaying, or abolishing some immediate response becomes much more accentuated. Indeed, it appears that this possibility of influencing responses is an important factor in the mechanism of conditionality of lower orders, but becomes the *main factor* in establishing the *degrees* of conditionality of higher orders. Obviously, the reactions become very labile, the adjustment to conditions very subtle, allowing the organism to survive under the most complex conditions, such as are found in highly 'civilized' life.

This mechanism is responsible not only for human intelligence, but also for all that is constructive in so-called 'civilization'. Vice versa, for survival in such complex civilization, one must possess these *fully* conditional reactions. At this point, it will suffice to mention that in organisms below humans, 'inhibition', which underlies the mechanism of conditionality of reactions, plays a most important biological and survival role, while on the human level it is the foundation on which all human *s.r*, 'intelligence', and desirable human characteristics are built. The present theory introduces methods to make the application of the above considerations possible in daily life.

All possible analysis depends not only on definitions of terms but also on *undefined terms,* which, outside of mathematics, have seldom, if ever, been investigated, thus making the structural assumptions which they introduce unconscious. In definitions, we also usually posit structure, though we seldom realize this fact. When we approach the experimental side of science, which is the search for empirical structure, the implications involved consciously or unconsciously in the defined and undefined terms play a very important role, and they direct, to a large extent,. our efforts and ingenuity. This is why we still have so few genuinely creative scientists, although since the psycho-logically and semantically liberating world of Einstein, the number of creative physicists of the younger generation has increased surprisingly. Yet the majority of scientists do not realize to what extent their *s.r* are influenced by the terms they use and what enormous help and creative freedom they would have from being conscious of the role the structure of language plays.

With this realization, before we begin the constructive analysis of such an important term as 'inhibition', we must state clearly what the general biological presuppositions which underlie such an analysis are.

The present work is a $\bar{A}$-system, structurally very different from the older systems, which attempts to build a verbal system of similar structure to the empirical structures, as given by science 1933. The older systems had also a structure similar to the very limited knowledge of empirical structure which our primitive ancestors had. Hence**,** animism, anthropomorphism, 'psychologism', and the rest, and the persistence of such structural features in science as ‘inhibition’ in neurology, ‘force’ and ‘heat’ in physics , .

According to scientific standards of 1933, there is, as far as I know, only one biological system in existence which can be called modern, and this is the $\bar{A}$ biology of Professor C. M. Child (see Chapter VIII). It is, therefore, necessary to accept this system, and also the $\bar{A}$ neurology of Professor Herrick, which is based on this biology.

Generally, the neurologists tell us that the structural aspects of ‘inhibition’ are unknown. To a large extent, this is true, although it is quite obvious that a ‘*psychological*’ term cannot shed any light on its physiological structure. To get glimpses of this mechanism, we must start our analysis quite low in the scale of life and see what the most general characteristics of protoplasm are.

All protoplasm is irritable. In any undifferentiated bit of protoplasm an excitation must (1933) spread in a diminishing gradient, establishing, by necessity, a region of highest excitation in contact with the stimulus, resulting in a polar orientation, with an eventual future head-end, and establishing a physiological gradient, long preceding the appearance of any differentiated tissue. The nervous system is a later outgrowth of such an oriented dynamic field, and its primary morphological and physiological characteristics are, to that extent, predetermined, being, in the meantime, a joint phenomenon of the inherent characteristics of protoplasm, its irritability, conductivity, and what not, and of its reaction to the environment. The physiological gradient is, then, the simplest and the most general primary reaction arc in a given individual, and constitutes the physiological basis for the structural and functional development of all other arcs.[1]

Amoebas are primitive little aquatic animals of approximately spherical symmetry which have no differentiated organs at all; yet they show quite complex reactions and various adaptive activities to be found in higher animals. The amoebas can pursue their victim, show preference for stimuli, and move away from the prick of a pin, select their food, . This fact shows that protoplasm, so little differentiated, and, from the organic point of view, undifferentiated, exhibits both muscular as well as neural characteristics. This fact is fundamental. It shows that in colloids which happen to be sensitive and which possess a special type of conductivity, which, from a physico-chemical point of view, is only a special aspect of one mechanism, there is already present the potentiality for any further development. Professor Child’s physiological gradients, the structural precursors of the nervous system, are a necessity, because of the dynamic potentialities of the plenum and the necessary relation to the environment, as there is no such thing as anything without environment. The stimulus, in the meantime, establishes structurally a functional polarity as a fundamental characteristic of all, even most primitive, protoplasm, and as the result of the contact of sensitive and conducting colloidal structures with the environments.[2]

In sponges, which have primitive muscular tissue but no nervous system, the muscular tissue exhibits also both characteristics, combining receptive and motor functions, showing that from the start the. supposed muscles are, in reality, neuro-motor organs.[3] The actinians have no central nervous system. By the aid of an incision, we may produce in them special additional growths of tentacles sometimes with a mouth, sometimes without. If, in the last case, we place a piece of food in the tentacles, they will bend toward where the mouth should be. If we cut such a tentacle away from the body, we still find that in contact with food it will bend in the one direction. But here we are dealing not only with the sub-microscopic dynamic structure but with macroscopic structure, where the irritability and the structure of the peripheral organs determine the reaction.[4]

When we experiment with animals with a more developed nervous system, such as ascidians or worms, we come to new and very instructive facts. Loeb has removed the ganglion from a number of *Ciona intestinalis,* a large transparent ascidian, which normally, when touched at the oral or aboral opening, closes the openings, and the whole animal contracts into a small ball. It appears that a few hours after the operation mentioned they relax. If a drop of water falls on such an animal, the characteristic reaction appears again, showing that the reaction was not due to the ganglion but is determined by the structure and arrangement of the peripheral parts and the muscles. The nerves and the ganglion play only the main role as a quicker conductor for the stimulus.

Even in higher animals we find vestiges of such primitive generalized mechanisms. For instance, Loeb, in his experiments in removing the brain from sharks, found that, even after death and when signs of decomposition had already begun, light produced a contraction of the pupils.[5]

In a decapitated worm, practically all normal reactions are retained. If we cut the nervous system of a worm in two, the two parts of the worm move in a co-ordinated way as long as they are connected by a little bit of tissue. The experiments were carried further: a worm was cut in two completely, the two halves were connected by a string, and they still moved in a co-ordinated way, showing once more that originally the nervous system was a specialization of general protoplasmic characteristics of irritability and conductivity and structure, which, at present, are known to be strictly interconnected.[6] Multiordinal structure is the explanation of this behaviour. Similar examples could be given in great numbers, all of which would support the above well-established view.

Among the general protoplasmic characteristics we do not find 'inhibition', but only positive excitation and conductivity. This issue is fundamental and should be taken as a foundation for further analysis.

If a wandering amoeba comes to an illuminated spot, the animal will not remain in that region. Here is, seemingly, a new fact, and we must *select* the language we want to use in this connection. If we follow the old animism and anthropomorphism, we could say the animal 'knows'. , or that some 'demon' has forewarned it, or, with equal justification, say that it is an example of 'internal inhibition' or 'prohibition'. The introduction of such terms, of course, explains nothing physiologically, but simply multiplies metaphysical identifications on the unconscious yet false to fact assumption that a word 'is' the thing we are talking about—a vestige of the primitive 'magic of words'.

Loeb pointed out long ago that to be forced to introduce animism and anthropomorphism is enough *to neglect the analysis of an external stimulus.* This is true not only in biology, physiology, neurology. , but also in physics. The difference between the N and $\overline{N}$ systems depends on the fact that Newton did not take into consideration the character of the stimulus, the finite velocity of the ray of light, which is fundamental in any observation, but that Einstein did take this into consideration. The ∞-valued determinism (the restricted principle of uncertainty) in the newer quantum mechanics depends on taking into account the disturbing effects an 'observation' has on the 'observed',.

What are the known facts in the meantime ? Let us start with the character of the stimulus, light. We know, positively, that light can be considered a very potent stimulus, and so the behaviour of the amoeba was a direct response to this stimulus. In fact, we know a little about this mechanism without introducing any 'demons' or 'internal inhibition'.

The starfish of a certain species has a symmetrical structure consisting of five arms. Its nervous system consists of a central ring around the mouth and peripheral nerves radiating from the ring into the arms. If such an animal is laid upon its back, it will right itself, but it is essential that not all arms should move simultaneously. In a normal animal, having five arms, usually three arms do the work and two of them remain quiet. If we destroy the nervous connection between the arms, this co-ordination is destroyed; all five arms begin to struggle, and the starfish cannot right itself, unless by accident. Should we again invoke 'demons' or 'inhibitions', or analyse the stimulus-complex and its effect ?

Obviously, when the starfish is put on its back, a new stimulus-complex is operating upon it, resulting in a complex adjustment.[7]

As we already know, any stimulus applied to a bit of living protoplasm, because of the colloidal structure and of the inherent irritability and conductivity of the plenum, produces a physiological gradient, establishing, thus, some sort of polarity, symmetry, relations, order, and structure, and indicating what structure our language should have. Again, no trace of any 'inhibition' or 'prohibition' is found, and on the silent, un-speakable, objective level everything happens the usual way, without any regard to, or respect for, our t*alking*. Talking only becomes a very genuine danger when on language of primitive structure we build our creeds, institutions, rules of conduct. , and our methods of investigation. In the last case, our sciences are nearly as slow, halting, perplexing, difficult, non-co-ordinated, and, in a larger sense, ineffective, as our creeds and institutions have proven to be. Our sciences may have added to our comfort, but, outside of psychiatry, they have not contributed much to human happiness.

As structure seems so fundamental and can be discovered everywhere, we should not be surprised to find that in structure, or perhaps, still better, in the general structuro-sensitive-conductive dynamic complex with definite structure on different levels, we shall find the solution for obvious positive reactions of organisms, as well as for the lack of them.

It is not possible or necessary to go into further details here. The structural data, however, although they are not particularly emphasized, are given in handbooks of physics, colloidal chemistry, chemistry, biophysics, biochemistry, biology, physiology, neurology, . At present, it is realized in science that structure is of extreme importance; but, because of identification, it is not realized that structure is *the* only possible *content* of science and of all human 'knowledge'. This fact, of course, makes the quest of science uniquely structural. Because of it, we come to a very far-reaching general rule, that all 'understanding', to be such, must exhibit or assume structure, thus formulating the supreme aim, and, perhaps, uniquely indicating the only possible method, of science.

Two more simple examples may be helpful. *Mnemiopsis* or *Eucharis* have swimming plates which beat rhythmically, with considerable regularity. When the plates are stimulated mechanically, the movement ceases in the presence of sufficient calcium salts in the water. In similar media, but containing no calcium, a mechanical stimulus does not stop the movement of the plates, but just the opposite. It accelerates their motion, showing clearly that the effect of direct stimulation can be reversed when the structural relations are altered. Once more, no ‘demons’ and no ‘inhibition’.[8]

In higher animals, we usually find a well-developed symmetry and muscles of which the activities oppose the results of the activity of other muscles. Such muscles are called antagonists. If two antagonists of equal strength are stimulated equally, no macroscopic effect of the stimulation of both muscles results. If one of the antagonists is stronger than the other, the macroscopic effect of the stimulation of both muscles results not in some general convulsion, but in a one-sided action of the stronger muscle. Obviously, these results are the necessary consequence of structure on different levels. We had, in the first case, a lack of obvious macroscopic reaction, although stimulation was present and did its work. This was due to structure.

It is known that some drugs, such as strychnine or the toxin produced by the tetanus bacillus, produce a state of *general* and high irritability of the nervous system. The slightest stimulus to the surface will produce a spasm which affects practically every muscle of the body. The pinching of the foot, instead of producing a withdrawal, results in the rigid extension of the legs, arms, and back. The extension is no longer a co-ordinated process, but is associated with strong contraction of the flexors, the final state of the limbs being determined by the surpassing strength of the stimulated extensors. The effect of the tetanus toxin is similar. In a monkey, under normal conditions, the electrical stimulus of a certain spot of the cortex will produce the opening of the mouth; similar stimulation of another spot will produce the closing of the jaws. But, under the effect of the toxin, the stimulation of any of these spots will produce the *closure* of the jaws, because any attempt to open the mouth will excite the stronger masseter muscles and effectively close the mouth.[9]

The above examples show again that no ‘demon’ or ‘inhibition’ has prohibited the withdrawal of the foot or opening of the mouth, but that the excitation of stronger antagonists is responsible for the result—or, if we wish, for the lack of results. All of which is obviously structural.

All the above discussions and examples—and they could be expanded and extended to fill volumes—show clearly: (1) That in the structurally more complex organisms the process of co-ordination and adjustment to more and more complex environmental conditions, leading to wider activities and fuller conditionality of reactions, is partially based—to the extent of one-half, or even more—on the lack of direct response to a stimulus, leading to delayed action and involving the four-dimensional order, all of this being a function of the entirely general characteristics of protoplasm; namely, its structure, excitability, and conductivity (the last two characteristics being also a result of sub-microscopic structure) without the intervention of ‘demons’ or of ‘inhibition’; (2) that in every case there is an *excitation,* no matter whether the result is a positive or a negative reaction, or whether we can, at present, trace it in detail.

As Professor Herrick says: ‘On this view of the situation the supposed inhibitory effect of the cerebral cortex resolves itself into a differential dynamogenic cortical influence. This is partly specific and phasic, acting upon particular subcortical functional systems while these are in process and tending to depress all conflicting activities either by withdrawing available nervous energy from their apparatus of control or by equal activation of agonist and antagonist systems with resulting stasis. It is partly a general and tonic activation or reinforcement of all lower reflex systems. Upon removal of the visual cortex the specific phasic activation of learned reactions is abolished. Upon removal of the entire cortex the general tonic cortical effect is abolished. The operation has not stimulated inhibitory fibers, as some have supposed; it has removed the sources of tonic activation which normally are always operating.’[10]

‘The cerebral cortex from its inception exerts more or less inhibitory influence upon subcortical functions. In the simpler learning processes of rats there seems to be a differential activation of some key factor of a subcortical learning process . . . which in effect draws off all available cortical energy, leaving other and irrelevant sensori-motor processes relatively enfeebled so that they are subordinated. The effect is the same as if a specific inhibitory action were exerted by the cortex upon the inappropriate movements . . . It may be suggested, further, that all inhibition is in reality a differential activation, the mechanism being in some cases simply the “drainage”, phenomenon . . . and in other cases this effect supplemented by positive activation of two antagonistic motor mechanisms so that their interference blocks all reactions of non-adaptive sorts.’[11]

In these statements of Professor Herrick, we find a language of similar structure to the known facts. The terms of *differential dynamogenic cortical influence* and *differential activation* cover all known facts, and may cover future facts, because the terms are structurally very flexible, and will always allow us to enlarge our knowledge of the mechanism of the so fundamental *differential activation.*

The difficulty in eliminating the term ‘inhibition’ and suggesting a new physiological term to take its place is considerable, because this term is used in many different forms and meanings. The term ‘inhibit’ is used in its various forms as a substantive, an adjective, a verb, an adverb, sometimes as a psycho-logical term, sometimes as a physiological one, yet *never* carrying physiological implications, but always psycho-logical and anthropomorphic ones connected with its origin and standard use. It was introduced into science when physiology and neurology were in their infancy, and so were still under the influence of primitive animism and anthropomorphism.

The term, because of its character, is not scientifically descriptive. It does not suggest functional, actional, directional, or other structural implications, but suggests notions irrelevant to science connected with its origin and standard use, making it a far-fetched inferential term, the use of which must retard the advances of these sciences.

Once we introduce a physiological term with physiological and, therefore, structural implications, our expressions will have to be reshaped to make the use of the term possible. Such re-wording will always carry quite definite structural implications, which, in turn, suggest further experiments in the search for structure and so have a *creative* character, not to be disregarded. Thus, as we have already seen, the term of 'degrees of conditionality' suggested further experiments and the revision of older data.

This statement is quite general and may be summed up as follows: The introduction of a new structural term may: (1) eliminate the improper implications of the older terms; (2) introduce new and creative implications which suggest the need of verification and so lead to new experiments.

At this point, I suggest a term which may be useful and will, perhaps, be acceptable for scientific use. As the fundamental character of 'inhibition' seems to be 'differential activation', the term to be coined should possess two main structural implications: (1) it should be directional, or indicate the sense of the reaction, and (2) it should imply activation.

We find such a term in 'negative excitation', 'negative stimulation', 'negative activation', 'negative phase'. , and it is possible to extend the use of this term by making as many compound terms as we need.

If possible, we should have terms which help us to keep on one level of analysis, and so automatically prevent us from confusing levels, since modern science always deals, at least in principle, with not less than three levels, the macroscopic, the microscopic, and the sub-microscopic, thus making confusion quite easy. If we call the positive effect of a stimulation on the macroscopic level 'positive', any other stimulation which might fail to produce the positive effect on *this level*, or which might counteract it, would be negative. The implication would remain that there was some excitation, but that it did not produce the effect which we had called positive. Structurally, such a term would be satisfactory, especially as it would help us to keep on one level of analysis and not confuse the main levels through verbal structure.

Such a language would help us to study the mechanism of ‘differential activation’, and would carry helpful implications. If any cases appeared in which this term did not cover the field, either the term could be enlarged, keeping the implications, or the statements should be altered so as to be expressible by such terms. The last would always prove to carry interesting implications, suggesting experiments.

In the processes going on in the nervous system, there is no occasion for the application of terms like ‘prohibition’ or ‘inhibition’. There is no standstill in these sub-microscopic processes, though the manifestation on the macroscopic levels can be either of a positive or of a negative character. On the sub-microscopic levels, there is a nervous excitation which often stimulates antagonistic processes. , with results which are not always obvious.

The implication of the term ‘negative excitation’, although limited, is structurally correct in 1933. Without going into full detail here, I merely suggest a few considerations. First of all, the term preserves its main implication; namely, that of excitation, ‘negative’ suggesting that this excitation takes an opposite course to the positive one. If, for instance, a positive excitation produces, let us say, the activities of the salivary glands, a negative excitation in this respect will not produce them but will produce other activities, such as, for instance, an investigatory reaction. With a negative excitation, there is an excitation, but it produces different results. There is no possibility of stopping or prohibiting or inhibiting nervous activities, short of death as-a-whole or destruction in parts; but only a possible deviation of activities, owing to enormous possibilities in establishing nervous connections, endlessly subtle dynamogenic effects, .

In some instances, ‘inhibition’ might be regarded as a form of nervous exhaustion; but such a notion cannot always be structurally correct, as there is much evidence at hand that ‘inhibition’ spreads to other cortical elements which were not functionally exhausted, or that it can be counteracted by some new excitation. ‘Inhibition’ thus preserves its *active* character. The origin of ‘inhibition’ is also very instructive, and a mass of experimental data shows that it can be produced experimentally. Among other ways, it can be produced by very weak, very strong, or unusual stimuli, *but stimuli, anyway.* As a rule, any extra nervous *excitation* in the central nervous system manifests itself at once, either in diminishing, or in completely abolishing (temporarily, at least) the conditional reflexes prevailing at the date.[12] If we find that exhaustion is, in some instances, the structurally correct term, there is no reason why we should not use it, instead of using a *psycho-logical* term of ‘inhibition’, on neurological levels.

That the terminology of positive and negative *excitation* is structurally appropriate finds its further support in the so-called ‘disinhibition’. Thus, an ‘inhibition’ of an ‘inhibition’ reverses the neural process prevailing at a given ‘time’ and becomes a positive excitatory one. In our language, because of structural considerations, we should say that ‘disinhibition’ should be labelled as ‘negative excitation of *second degree*’, resulting in a positive excitation. If we were to ‘inhibit’ ‘disinhibition’, we should have, again, ‘inhibition’, . With the new terminology, it would be a negative excitation of the third degree, which would give negative results, and a general rule could be established, in complete accordance with the mathematical language in which the even degrees of a negative excitation would have positive characteristics and the uneven would remain negative (‘inhibitory’).

Such a language would not just borrow ‘by analogy’ some mathematical features. Once we take structure into consideration,—and linguistic issues represent an adjustment of structure—when a systematic analogy is found, it has always structural implications which should be used for testing structure. There can be no serious objection to the statement that mathematics is, at present, a limited language of which the structure in 1933 is similar, or the most similar we have, to the known structure of the world and our nervous system. The use of such language must be always desirable, as it is a test of structure and so leads to further discoveries of the unknown structure of this world. To the best of my knowledge, the above is a novel, very general, structural use of mathematics considered as a prototype of languages. Our emphasis is now on the *structure* of mathematics, and not on the numerical solutions of equations, the *possibility and usefulness* of which is precisely due to the fact that equations express relatedness, and so necessarily give us structural glimpses.

From a structural and linguistic point of view, the historical development of mathematics shows that it is a first successful attempt to develop a language with a structure similar to the empirical structures, and shows the ideal conditions of producing languages.

When we had only positive numbers, we could add two and three and make five, we could subtract two from three and have the remainder one, but we could not subtract three from two. Yet the structure of this world is such that a further development in the structure of the language was imperative. Thus, if an object moves in a given direction with the velocity two feet per second, and some external factor imparts to it a velocity of three feet per second in the opposite direction, the original direction of motion will be reversed, and the object will move with the velocity of one foot per second in the opposite direction. Or, to give another example, some one has two units of money and he buys something which costs three units of money. He is then in debt one unit.

Such facts necessitated the introduction of negative numbers and so made subtraction always possible. If the motion in one direction or the amount of money in our pocket was called ‘plus two’ units, and we subtract from it three units, the results were ‘minus one’, meaning a conventional reversal of direction, or sense, for motion, or a debt, instead of a possession, for money.

Experimental facts of division again necessitated the expansion of this language. Thus, fractions were introduced so as always to allow of linguistic division. The ‘imaginary’ number, $i=\sqrt{-1}$, was introduced to allow, in all cases, the extraction of roots , . For a long ‘time’, the number $i=\sqrt{-1}$ was considered almost mystical, but, of late, when a physicist or an engineer finds it in his equations, it is almost an unmistakable indication for him to look for some wave-motion in the world. More extended observation of the empirical world and structure required further structural adjustment of our languages.

In the vector calculus we have the so-called scalar product which obeys the ordinary laws of multiplication and $a.b = b.a$ where the order of the factors is of no importance. The vector product does not follow these rules, as the order becomes important; thus, in a vector product, $a.b=—b.a$. In the newer quantum mechanics, to account structurally for the experiments, still newer numbers were introduced. Instead of the old arithmetical $qp=pq$ or $qp-pq=0$, we introduce new numbers where

$$qp - pq = \frac{ih}{2\pi}.1 .$$

It is very significant that a similar linguistic evolution appears justifiable in the case of the function of the nervous system in general and in the structure and function of the conditional reactions in particular. As experience and theory show, the fundamental structures and functions we find in life are not ‘plus’ affairs, but represent some higher degree functions of a non-additive character. The typical functioning of the human nervous system (time-binding) is represented by an exponential function of ‘time’.[13] Now we see that the reversal of the sign of negative excitation also follows exponential rules, and experiments show that the change in order of abstractions which, by necessity, must be passing from even to uneven numbers of orders or vice versa, also reverses the sign of the reaction (see Part VII).

In the case of positive excitation, there is also a structural parallel with the newer languages of mathematics, but we do not need to analyse it here, because the foundation of the more flexible, adjustable responses begins with a negative effect; and, in this case, the language I suggest is fully justified without further explanations. The neurological importance of 'consciousness of abstracting' is based precisely on the fact that it automatically involves a fraction of a second of psycho-logical delay, and thus is fundamentally based on, and introduces in training, a wholesome 'inhibition'.

We come thus to a weighty structural conclusion that the fundamental processes of the nervous system are not only non-plus processes but that they follow the exponential rules of signs. As soon as we realize that from a structural point of view 'structure' and 'function' are only different types of language in which to speak about two aspects of what is going on, on the silent un-speakable level, and that on this level these two aspects *can never be divided*, we must also build a *non-el* language. Such a language is found in *dynamic structure*, out of which arises function, and even macroscopically relatively enduring structures as special aspects, and the exponential character of the fundamental activities of the nervous system becomes a necessity.

In modern mathematics numbers can be interpreted as operators. , which, in our case, suggests great freedom of structural use, and widens the application of these notions.

To put the problems as simply as possible: all the more subtle forms of adjustment in organisms, 'intelligence', so-called 'civilization', our 'ethics', 'happiness'. , and, finally, *sanity*, which is the evidence of semantic adjustment or proper evaluation on human levels, are based on the neurological interplay, the number, and multi-dimensional order of superimposed (not added) positive and negative excitations. The positive, or the direct and obvious, responses are the more primitive; the negative, resulting in not always obvious consequences, are the result of further structural complexities, which reach their culmination in the normally developed highly cultured man.

Such indefinitely superimposed negative excitations are found physiologically in the hierarchy of higher and higher orders of abstractions; which are able to reverse the sign of the *s.r*, and so, structurally, make these considerations extremely workable and neurologically sound, and justify their introduction and use. This accounts for the fact that what was evaluated as tragic or painful, or joyful, or shameful. , to one generation or culture, does not seem so to another. Our personal difficulty usually is that, at present, we copy animals in the relative unconditionality of our responses, because we are not acquainted with this semantic mechanism. We are not prepared to change in one single generation the sign from a minus to a plus, or vice versa, without a great amount of struggle and semantic discomfort.

Now, such discomforts are usually harmful to the human nervous system, but the structural understanding of this mechanism helps us to eliminate these semantic pains, and so leads toward nervous balance and sanity.

It seems that the neurological mechanism operating in this connection is similar to the one formulated by Pavlov, thus: 'Two facts relating to the central nervous activities stand out clearly. The first is that the extraneous stimulus acting on the positive phase of the reflex inhibits, and acting on the negative phase disinhibits, in either case, therefore, reversing the nervous process prevailing at the time. The second is that the inhibitory process is more labile and more easily affected than the excitatory process, being influenced by stimuli of much weaker physiological strength. ,!'

Negative reactions or 'inhibition' must be interpreted as the neurological foundation of 'human mentality', and the result of external and internal stimulations. Because of structural interrelations, the main factor of building human 'mentality' and developing internal 'inhibition' must be more labile and must be influenced by stimuli of much weaker physiological strength.

This explains also why the solution of our problems in education, social life. , must be not the animalistic external 'inhibition' alone, but must become, in the main, special internal 'inhibition', effective and yet harmless to the individual nervous system. All of us possess this most general nervous mechanism. The problem is to discover the means to operate it. We shall see later that in consciousness of abstracting we find a workable semantic solution, allowing an automatic change of sign of the reaction. It should be recalled here that all stimuli and all responses are complex, the word 'simple' being structurally false to facts. On the human, and particularly on the linguistic level, it is practically never possible to ascertain an 'absolute' order of abstraction, or the degree or order of an excitation. These are often the results of racial time-binding, and extremely complex, nervous processes, and every superimposition of a new neurological process (not addition) may fundamentally alter the whole character of the *s.r* and reverse the sign. In negative excitations, the passing from one degree to another changes the sign of the reaction. In practice, we are only interested in two neighbouring levels of abstractions or in two neighbouring degrees of negative excitation, simply because these involve, by necessity, a passing from an even to an uneven degree or vice versa—in both cases reversing the sign of the *s.r*.

The general organismal adjusting mechanism of the 'investigatory reaction' responds positively to a new stimulus, but with very important survival value acts negatively on established positive conditional reactions in animals. It is, at present, much weakened and often ineffective with man, resulting in non-survival, non-adjustment and 'mental' ills for man. It is a well-established fact that different stimuli either interfere with each other, resulting in modified behaviour, or reinforce each other and have cumulative effects. On the human level, different 'mental' factors play the role of internal positive or negative excitatory semantic complexes, which, because of verbal conditions (and all doctrines are *always* connected with an *affective* background), may reinforce a given stimulus, thus making its physiological effect variable and of different strength. Under such conditions a new stimulus does not produce the investigatory reaction with all its beneficial results. This mechanism is, perhaps, responsible for the well-known fact that primary instincts with humans are, by far, weaker and more variable than with animals; whence it comes that *humans seldom know by themselves, without science, what is best for them.*

We should not be surprised to find that under these more complex conditions human investigatory reactions may be of different types, culminating in the *typically human* investigatory reaction, which would introduce the natural, yet more important, *delay in an immediate reaction* to a former stimulus. We shall find, later, that consciousness of abstracting is such a distinctly human and very useful investigatory reaction that on the human complex semantic level brings relatively as much benefit to the human organism as it does on the animal level to animals.

It seems that the nervous mechanisms of both types are similar, except for the fact that on the human levels we have more factors which are external and internal stimuli than on the animal level. If we copy animals in our nervous processes, we are, in reality, worse off than the animals, because, with our more complicated nervous system, it means for us a pathological condition.