

CHAPTER XXI

ON CONDITIONAL REFLEXES

The conditioned reflex is conventionally regarded as differing essentially from the unconditioned reflex, but this is contradicted by evidence drawn from the development of behavior. (107)

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The main experiments of Pavlov were made on dogs, animals with a rather well-developed nervous system; and so most of what he has to say is about dogs, although some general physiological facts apply to all the higher nervous systems, man included. In some instances, because of human complexities, some results must be re-interpreted, structural linguistic re-adjustments made, and some obscuring, wrong-in-structure, *el* 'psychological' terms analysed and rejected. My linguistic, structural, *non-el*, *theoretical* revision leads to a new and important enlargement of the application to man of the Pavlov *experimental* theory of 'conditioned' reflexes. The fact that these independent discoveries reinforce and support each other is a striking instance of the usefulness of theoretical researches.

We must take care to notice and beware of the differences in languages. Any happening has as many aspects as there are sciences, or even human interests. Thus, if we speak about an objective 'pencil', we may speak about its chemistry, or methods of manufacturing, its uses, prices, markets, . As the content of knowledge is structural, we must search empirically for structure, understood nowadays always on three levels (the term being multiordinal), the macroscopic gross structure, the microscopic, and sub-microscopic structures.

When we deal with life phenomena, we have also different languages dealing with their different aspects. Thus, a biological language would cover eventually the vital events in general; a physiological language would be narrower and cover the analysis of phenomena in an organism, the function of its organs and the conditions and the mechanism which determine these functions; a neurological language would be physiological as applied only to the nervous system. The day is not distant when all these problems will be formulated in the language of the quantum mechanics.

A psycho-logical language is legitimate only on human levels, as we never know, or can know, what an animal 'thinks', 'feels'. , and on human levels it applies to so-called 'psychic' phenomena only.

Usually, one extremely fundamental semantic fact is disregarded; namely, that what on the psycho-logical level is *objective* and in language *descriptive* to one person (e.g., 'my toothache') , is *inferential* to the other

person, and vice versa. The lack of consciousness of abstracting introduces, by structural necessity, an identification of orders of abstractions; namely, the confusion of descriptions with inferences, and vice versa. This makes it imperative to avoid psycho-logical language as much as possible. It is also bad epistemology to use a language which applies to a few individuals (psycho-logics) for describing functions which are much more general, and which, fundamentally, apply to all organisms.

It is a striking fact that, although physiology is a fairly old and well developed discipline, yet the purely physiological approach to the study of the brain-functions is very recent, and, in the main, has been carried on by Pavlov and his followers. Pavlov gives us a simple yet profoundly true explanation; namely, that the higher nervous centres have never been treated on equal footing with other organs, or other parts of the nervous system. The activities of the hemispheres have been treated from a 'psychological' point of view, and, by analogy, we have ascribed to animals similar 'psychological' states, . a remnant of primitive animism. As such attitudes have become more and more obviously absurd, we have drifted into the opposite absurdity of animalism, ascribing animal characteristics to man, forgetting that the human nervous system is far more complex, matures later than in any animal, and is a non-additive affair. Naturally, reasoning by such analogies must be fallacious.

The prevalent complete disregard of the fact that these issues are linguistic and structural makes the advances in these fields very slow and halting, and only so-called 'geniuses' are capable of breaking through these semantic barriers. Once the linguistic character of the issues is fully realized, the psycho-logical, semantic blockage is removed, freedom of analysis is inwardly established, and even 'non-geniuses' will produce important creative work. Indeed, we may find that with this realization, particularly if embodied in early education, the 'normal' man would be, what we call at present, a 'genius'.

This conclusion naturally follows if we abandon animalistic analogies and face the fact that high-grade human intelligence happens to be not less 'natural' and inherent in the history of evolution than any other 'tropism'. By eliminating the psycho-logical semantic blockage due to copying animals in our nervous reactions, we may handle this important *human function* of language properly. Man will function as *man*, in accordance with the structure of his more complex nervous system. There is no doubt at present that some organisms called 'man' have an important function connected with *s.r* called 'speech', perhaps the most complex and involved and also *unique* function evolved by this class of life. and which it does not yet know how to use. Biologically and physio-

logically, this misuse of a function must be a *non-survival tendency* for *this* class of life.

Sanity must be based on methods for the most efficient use of the human nervous system, in accordance with its structure, and will thus bring about the full working of human capacities, which at present are still semantically blocked by faulty handling of the apparatus.

Before going further, I will analyse and suggest the complete elimination from the English language of the term 'conditioned' reflex, which is structurally false to facts, and suggest in its place the uniform use of the term 'conditional' reflex, introduced by Pavlov and used occasionally by some English writers. I will also suggest the elimination of a *psycho-logical* term, 'inhibition', from physiology and neurology, in which it should have no place at all. Such a change in language leads to new results, and also suggests new experiments. It is little known and seldom taken into consideration that long ago Locke was quite clear on the point that the misuse of language has often been taken for deep mysteries of science; but Locke, unfortunately, did not take into consideration *structure*, and *s.r.*; so his arguments were, in general, non-operative.

As everything in this actual world is structurally interrelated with everything else, we should consciously look for interrelations; in which case we have to build special languages for the eventual synthesis. As we must first ascertain empirical structure, and only then coin the languages, obviously to start with a descriptive, impersonal, non-'psychological' language of ordered events on a given level is most important.

In our case, we are investigating the structural and semantic problems in connection with language. We have to accept the structural facts as discovered by physicists, physiologists, neurologists, and other scientists, and then build a language similar in structure to the empirical world. The language in which the present theory is formulated is a physiological and neurological one, as it deals with observed impersonal functionings of the organisms called 'man'. When we reach results in a physiological language, these have, naturally on the human level, a psycho-logical aspect, and perhaps the main importance, and even value, of the present work is that it reaches the very difficult psycho-logical, semantic level by purely functional and easily controlled physiological methods.

Thus the reader must translate for himself, as nobody else can do it for him, the physiological results into his psycho-logical feelings and attitudes and evoke the unspeakable *s.r.* These must be *evoked* by the reader, otherwise he will inevitably miss the point. For instance, if it is said that 'the objective level is unspeakable', the reader should try to become entirely 'emotionally' impassive, outwardly and *inwardly* silent

about an object, or a feeling, as whatever we may say *is not 'it'*. This, obviously, involves a complete checking of affective responses, 'preconceived ideas'. , making him an 'impartial observer'. In fact, to do this successfully is something very difficult to achieve, requiring long semantic training with the Structural Differential, and usually involving a complete reversal of our habitual modes of affective responses.

Similarly, when we speak of. 'natural order' or reversal of this order, let the reader try actually to evoke these *s.r.*, and he will find it is not so easy, as it involves a completely new process of re-evaluation. In both cases, we can gain physiological, easily operating means to reeducate the very stubborn semantic responses, by *functional and ordinal methods*. The difficulties are only serious with grown-ups; they present no difficulties in the early semantic training of infants, for whom this training becomes a powerful preventive method against future nervous disturbances (limited, of course, to this aspect of un-sanity).

Directly such a semantic re-education is accomplished, the formerly impossible is also performed, and 'human nature' has been changed. Obviously, the trouble has not been with 'human nature', but with the lack of physiological and educational means to affect the psycho-logical level and to change the *s.r.* The above applies to the so-called 'normal' man, as well as to the 'mentally' ill. It works with both types, provided the latter is in a condition to be at all accessible to approach.

The term 'nervous reflex' was originated by the mathematician Descartes. Structurally, it was a genuinely scientific notion. It implies necessity; namely, that a stimulus results in a response. Obviously, if such were not the case, an animal would not be in sufficient correspondence with its environment and could not survive. Thus an animal must be attracted and not repelled by food, it must avoid fire, and so forth.¹ The term 'reflex' is usually used in connection with *A* two-valued implications; this makes reflexology *el* and generally inadequate to account for organic *non-el* responses in the colloidal sense. In a \bar{A} -system based on the ∞ -valued semantics of probability, I prefer to avoid the two-valued implication and use the term reaction instead.

The main function of the nervous system is the co-ordination of all activities of the organism for its preservation. Thus there must be no conflict between the opposing activities of different parts of the organism, and any action must ultimately benefit the whole. There may be a conflict of different excitations, but one must finally dominate the others, as otherwise co-ordination would be impossible.

If food or some noxious material is put into the mouth of a dog, a secretion of saliva is produced, either to alter the food chemically and

help digestion, or to wash the mouth out and eliminate it. But observation shows further that other factors, not food or noxious materials alone, may produce similar secretions. Thus, for instance, the sight or smell of some such material, or of the person who usually administers it, or even the latter's footsteps may produce salivary secretions.

To make the experiments as exact as possible, the dogs observed by Pavlov were submitted to minor operations. Among others, the opening of the salivary duct was transplanted to the outside of the skin, so that all secretions could be carefully and exactly collected and measured.

The principle which underlies these experiments is the observation that if we combine some hitherto neutral stimulus, such as a definite tone, colour, or shape, with the presenting of the food or acid, after a few trials this neutral stimulus acquires the potentiality of producing similar secretory effects as the food or acid itself.

This fundamental and exact method of experimentation allows considerable freedom in the selection of neutral stimuli, affecting, as we prefer, the visual, or auditory, or tactile, or other nerve centres of the animal. We can also control their numbers, intensity, their combinations, the *order* and *delays* in their application,.

If food or noxious materials are placed in the mouth, the secretion of saliva is an almost automatic reaction, owing to the physico-chemical action of these materials. Such reaction is inborn and practically general for a given species, the nervous paths for such reactions being mostly completed at birth. Not so with the reactions produced by neutral stimuli, which acquire the secretory characteristics only after some experiences. These characteristics are reactions acquired during individual life, and the nervous paths and connections have to be completed during the lifetime of the individual.

Thus, when puppies are shown meat or bread, which they had never eaten before, usually no salivary secretion appears. Only after eating meat and bread on several occasions will the sight of them produce secretions.

Some of the effects of these acquired reactions are very strong and lasting. In some experiments, the dogs were given a hypodermic injection of morphine. The usual effect of the drug is to produce nausea with profuse secretion of saliva, followed by vomiting and deep sleep. In further experimenting, it was found that the preliminaries, or even seeing the experimenter, without injection, was often enough to produce the effects of the actual injection of the drug.

Pavlov studied the nervous mechanism of the functioning of the salivary glands, not because of any special physiological importance of

these glands, but because such experimenting was the simplest, and the method used allowed him to conduct the most varied experiments under accurate control.

The experiments disclosed an amazingly subtle and complex nervous mechanism, probably typical for the functioning of other glands of internal secretions. These findings, when translated into a language applicable to the human level, disclose a great deal about the nervous mechanism underlying so-called 'associations' and other 'mental', relational, or psycho-logical semantic manifestations. Usually, the salivary glands are not supposed to be as closely connected with psycho-logical manifestations as the thyroid, the adrenals, and other glands are known to be. It is, therefore, a new and very important general discovery of Pavlov that the salivary glands have such intricate and far-reaching nervous interconnections.

The example of the dog reacting to the 'associations' (relations) of the experiment with morphine in a similar way as to the actual injection of the drug, is a close parallel to the example already given, of the patient who reproduced symptoms of hay fever at the *sight of paper roses*. In this case, the 'associations' were also uncritical, compulsory, almost automatic, of the type found in the animals. In fact, this statement is very nearly general, and we shall find later that most of 'mental' ills follow neurologically the patterns of animal responses, and so become pathological for man. This observation has very far-reaching consequences, to be explained later; but we want to emphasize it from the beginning, and to stress the fact that copying animals in our nervous reactions must be detrimental to humans.

The above narrows our problem considerably: we have to discover only the main differences between the nervous responses of animals and humans, and draw our conclusions.

The alimentary reactions to food and the mild defense-reaction to noxious materials may be roughly divided into two components, the secretory and the motor. It was found possible to link another neutral stimulus to an already acquired reaction. Thus, if a dog was trained to respond to a bell, which was a signal for food, he could be trained, further, to link a formerly neutral stimulus, let us say, the sound of a buzzer, with the bell, and the bell with food. Such a secondary acquired reaction may be called of the *second order*. Naturally, it is very instructive to find out if these responses could be extended to more orders. Experiments disclosed the important fact that, as far as dogs and *alimentary* reactions are concerned, it was impossible to go beyond the second order. However, when *defense* reactions were tested, it was found that

it was possible to establish acquired reactions of the *third order*. But it was impossible to go beyond the third order, even in these cases.

In our field, where we have to formulate sharp differences between the nervous responses of 'man' and 'animal', we say that animals stop abstracting or linking of signals on some level, while humans do not. The latter abstract in indefinitely higher orders—at least potentially.

Here we encounter a fundamental and sharp far-reaching difference between the nervous functioning of 'animal' and 'man'. This abstracting in indefinitely higher orders no doubt conditions the mechanism of what we call human 'mentality'. If we stop this abstracting anywhere, and rest content with it, we copy animals in our nervous processes, involving animalistic *s.r.* As will be shown later, this is the actual case with practically all of us, owing to our A education and theories. This 'copying animals' in our nervous responses is, perhaps, a natural tendency at an extremely low level of development; but as soon as we understand the physiological mechanism, we can correct our education, with corresponding human semantic results. Naturally, such 'copying animals' by humans must be a process of arrested development or regression. It must be pathological for man, no matter how severe or how mild the affliction may be. Various absolutists, and the 'mentally' ill in general, show this semantic mechanism clearly.

The reactions can be divided into two groups, those which are *inborn*, almost automatic, almost unconditional, rather few and simple, belonging to the so-called 'species'; and those which are *acquired* during individual life, allow a great variety of complications, are *conditional in different degrees*, and are acquired by the individual. Pavlov suggests different terminologies; for instance, he calls the one 'inborn', the other 'acquired'; or as usually incorrectly translated into English as 'unconditioned' and 'conditioned' respectively. The two last terms have received a scientific general acceptance, yet I would suggest that in the English incorrect translation they are *structurally unsatisfactory*, and that particularly, when applied to humans, they carry harmful implications. Structurally, 'inborn' and 'acquired' are entirely satisfactory. Terms like 'conditional' and 'unconditional' (in the original language of Pavlov), although less satisfactory, are more appropriate, as they do not imply some sort of 'cause-lessness'. In fact, the 'unconditioned' salivary reactions *are conditioned* and produced by the physico-chemical effect of the food, and so to call them 'unconditioned' is structurally erroneous. The terms 'conditional' and 'unconditional' do not have similar implications, and carry others, as, for instance, the possibility of very important

degrees of conditionality, establishing the ∞ -valued character of the reactions; conditional meaning non-absolute, and non-one-valued.

For these structural reasons, I shall use the terms 'inborn' and 'acquired' or else 'unconditional' and 'conditional' reactions.

Under natural conditions, an animal, to survive, must respond not only to normal stimuli, which bring immediate harm or benefit, but also to different physical and chemical stimuli, in themselves neutral, such as waves of sound or light, which are *signals* for animals and *symbols* for man. The number of inborn reactions is comparatively small, and, alone, they are not sufficient for the survival of higher animals in their more complex environment. Experiments have made this point quite obvious. A completely decorticated animal may retain his inborn reactions and become a kind of automatic mechanism; but all his subtler means of adjustment, owing to acquired reactions, disappear, and if unaided he can not survive. Thus, a decorticated dog will only eat when food is introduced into his mouth, and would otherwise die of starvation though food be placed all around him.

Experimental evidence seems to show that all higher activities of the nervous system, the whole signaling apparatus, which underlies the formation and maintenance of the acquired conditional reactions, depend on the integrity of the cortex. Stimuli which produce conditional reactions are acting as signals of benefit or danger. These signals are sometimes nominally 'simple', sometimes very complex, and the structure of the nervous system is such that it can abstract, analyse, and synthesize the factors of importance for the organism, and integrate them into excitatory complexes. The analysing and synthesizing functions, as usual, overlap, and cannot be sharply divided, both functions being only aspects of the manifestation of the activity of the nervous system as-a-whole. In general, one of the most important functions of the cerebral cortex is that of reacting to innumerable stimuli of variable significance, which act as signals in animals and symbols in humans, and give means of very subtle adjustment of the organism to the environment. In psycho-logical terms, we speak of 'associations', 'selection', 'intelligence'. ; in mathematical terms, of relations, structure, order. ; in psychophysiological terms, of semantic reactions.

The language of reactions is of special interest because its structure is similar to the structure of protoplasm in general and the nervous system in particular. This language can be expanded and supplemented by the following further structural observations:

1) That reactions in animals and humans exhibit *different degrees of conditionality*;

2) That the signals and symbols may have *different orders*, indicating superimposition of stimuli;

3) That animals cannot extend their responses to signals of higher order indefinitely;

4) That humans can extend their semantic responses to higher order symbols indefinitely, and, in fact, have done so through language which is always connected with *some* response, be it only repression or some other neurotic or psychotic manifestations.

The above extension is structurally fundamental, because we can extend the vocabulary of conditional reactions to humans in all their functions. Without it, we find ourselves saddled with a vocabulary which does not correspond in structure to the well-known elementary facts concerning *human* responses to stimuli, and we relapse into the old 'behaviourism', which is structurally insufficient.

The present system is based on such observations and extensions. It was reached independently from structural and physico-mathematical considerations. With this structural verbal extension, we can easily be convinced that everything that we call 'education', 'habits', 'learning'. , on all levels is building up acquired or conditional and *s.r* of *different orders*, as one of the differences between 'man' and 'animal' consists in the fact that humans can extend their symbolism and responses to indefinitely high orders, while with animals this power of abstracting and response *stops somewhere*. We establish here a sharp distinction between the high abstractions 'man' and 'animal', and so build up a psychophysiological and structurally satisfactory language.

It is obvious that the fundamental means which man possesses of extending his orders of abstractions indefinitely is conditioned, and consists in general in symbolism and, in particular, in *speech*. Words, considered as symbols for humans, provide us with endlessly flexible conditional semantic stimuli, which are just as 'real' and effective for man as any other powerful stimulus.

Take, for instance, the example of the World War ! Would the men in the trenches have endured at all the horrors they had to live through if it had not been for words, and, neurologically speaking, because of the conditional *s.r* connected with words ?

'If any question why we died,
Tell them, because our fathers lied.'

said the poet truly, and experience shows it is not limited to the trenches.²

In interpreting the experiments on animals as applied to humans, it should be remembered that some of the experiments of Pavlov, *as they stand*, would be, at the least, *neurotic* for man. The reason for this is

that the higher abstractions of man, which are due to the more developed complexities of his nervous system, would often make such simple experiments impossible. Once a conditional reaction is established with an animal, no amount of any sort of 'intellectual' persuasion, or the like, would disturb his glandular secretions, as the animal's range of 'meanings' is very limited. These secretions can be diminished or even abolished by other means, but not by 'intellectual' means alone. In the 'normal' man, his 'knowing' that the sound of the metronome or bell is part of an experiment and not a signal for actual food, would, *or should*, alter his nervous reactions and glandular secretions and make the experiments much more complex. The conditional reactions of the animals have still the *element of unconditionality*. In man, they may become *fully conditional* and depend on a much larger number of semantic factors called 'mental', 'psychic'. , than we find in any animal.

On the human level, outside of the experiments with the salivary glands, we have in the psychogalvanic reaction a most subtle semantic means of experimenting with the effect of words as connected with some secretions, probably at least the sweat glands. Humans react to different events or words by minute electrical currents (among others) which can be registered by a very sensitive galvanometer and the curves photographed. It is interesting to notice that so-called 'self-consciousness' disturbs the success of the experiments, or makes them impossible, *at least with some individuals*. It should be remembered that general statements are invalidated if there are any exceptions.

In experiments, we are usually interested in their success. When analysing the ∞ -valued *degrees of conditionality*, we are equally interested in their failures, which suggest a far-reaching revision of the *interpretation* of our experimental data in this field. Although some writers say that the reactions registered are 'beyond control' (unconditional), this statement, in general, is not correct, and should be amended to 'often beyond control' (conditional of different degrees). It is impossible to go into details here, as the problems are extremely complex. In addition to this, the testing of *degrees of conditionality* presents an extremely wide *new semantic field* for experimentation which has not yet been attempted. It should be noted, however, in passing, that in these experiments different types of 'mentally' ill, as well as the 'healthy' persons, exhibit different types of curves.³

When psycho-logical events or *s.r* are interpreted, the difficulties become particularly acute. Thus, we seldom discriminate between the average and the 'normal' person. In the *animal world*, under natural conditions—by which is meant entirely without human interference—

the survival conditions are *two-valued* and very sharp. The animals survive or they die out. Because of this, it could be said, with regard to the animal world, with some sort of plausibility, that the average, with a long list of specifications, could be considered the 'normal' animal. We usually enlarge this notion to humans and land in fallacies, particularly in so-called 'psychological' problems, which admittedly are very difficult.

In general medical science, such mistakes are made more seldom. No physician, studying a colony of lepers or syphilitics, could conclude that a 'normal' man should be a leper or a syphilitic. He would say that probably, in a given colony, the average person is afflicted with such and such a disease, and he would keep as his medical standard for desirable health, a 'normal' man; that is to say, one free from this disease.

It is true that in the example given above, outside of such rare colonies, we have a majority which, in respect to the given disease, are healthy; so we are empirically forewarned against fallacies, although existing theories of knowledge do not forewarn us. But the main point remains true; namely, that in human life the average 1933 does not mean 'normal', and the standard for 'normal' will have to be established *exclusively* by scientific research. In our present work, we show that the average person copies animals in his psycho-logical and nervous processes, exhibits the unconditionality of nervous responses, confuses orders of abstractions, reverses the natural order. , semantic symptoms of similar *structure* as found in obviously 'mentally' ill. Therefore, the average person 1933 *must be considered pathological*. If we take the animalistic average for 'normal', and apply it to man, we commit a similar fallacy as that of treating a colony of lepers as a 'normal' or 'healthy' group.

In conditional *s.r* of man, the average person cultivates, through inheritance and training in A doctrines, languages of inappropriate structure. , animalistic, nervous, and so psycho-logical, *s.r*. But here, as in general medicine, the average pathological situation should not be considered 'normal'. Only a structural study can disclose what with man should be considered 'normal'. The present system performs this task to a limited degree and in various ways, among others, by the revision and the widening of the reaction vocabulary to a larger structural conditionality, as found in the, as yet, exceptional 'normal' man, and introduces the important notion of *non-elementalistic semantic reactions*.

Because of this 'average for normal' fallacy, the theories of 'conditional reflexes' in man should be thoroughly revised and enlarged to include *non-elementalistic semantic reactions*; and then we should find that often what is 'normal' with animals is quite pathological for man. The semantic difficulties are serious, because the accepted two-valued

structure of language and semantic habits reflect the primitive mythologies; so there is always the danger of drifting either into animalism, or into some other sort of equally primitive mysticism.

The net psycho-logical result of such a revision appears to be that, on structural grounds, what on human level appears as desirable, and, at present, exceptional—as, for instance, the complete conditionality of conditional and *s.r.*, based on the consciousness of abstracting—ought to be considered the rule for a ‘normal’ man. Then the older animalistic generalizations will become invalid and reactions transformed. But for this purpose, and to be able to apply these considerations in practice, we shall have to analyse ‘consciousness of abstracting’ and, therefore, ‘consciousness’ which must be defined in simpler terms, discussed in Part VII.

When we deal with ‘mentally’ ill persons, the reactions which would be conditional with ‘normal’ persons become, in a sense, unconditional, compulsory, and semi-automatic in effect, inwardly as well as outwardly. As with animals, no amount of ‘intellectual’ persuasion has any effect on them, and the reactions, secretions, follow automatically. From the physiological point of view, ‘mental’ ills in humans compare well with *conditional reactions in animals*. It seems that under such circumstances a physiological language of different orders of abstractions, different orders of conditional and *s.r.* would be structurally satisfactory. In such a language, we should pass from the inborn reactions, which exhibit the maximum of persistence, unconditionality, and almost automatic character, to the acquired or conditional reactions *in animals*, which would be called *lower order conditional reactions*, still, to some extent, automatic in their working, and, finally, to the much more flexible, variable, ∞ -valued and *potentially fully conditional reactions in man*, which we will call *conditional reactions of higher orders* which include the *semantic reactions*.

In such a vocabulary, the main term ‘reaction’ would be retained as a structural implication; yet the *degrees of conditionality* would be established by the terms of ‘lower order’ or ‘higher order’ conditional reactions. Such a language would have the enormous advantage of being physiological and ∞ -valued. Structurally, it would be in accordance with what we know from psychiatry; namely, that the ‘mentally’ ill exhibit arrested development or regressive tendencies.

We would say that ‘mental’ illness exhibits not only arrested development or regression, but we could state definitely that the *fully conditional* (∞ -valued) reactions of higher order have not developed enough, or have degenerated (regression) into *less conditional* (few-valued) reactions of lower orders as found in animals. All the ‘phobias’,

'panics', 'compulsory actions', identifications or confusions of orders of abstractions. , show a similar semantic mechanism of mis-evaluation. Although they naturally belong to the so-called 'conditional reactions', yet, being impervious to reason, they have the one-valued character of *unconditionality*, as in animals.

Similarly with the difference between signals and symbols. The signal with the animal is *less* conditional, more one-valued, 'absolute', and involves the animal in the responses which we have named conditional reactions of lower order. Symbols with the *normally developed man* (see discussion of 'normal' above) are, or should be, ∞ -valued, indefinitely conditional, not automatic; the *meanings*, and, therefore, the situation as-a-whole, or the context in a given case, become paramount, and the reactions should be fully conditional—that is to say, reactions of higher order. In human regression or undevelopment, human symbols have degenerated to the value of signals effective with animals, the main difference being in the *degree* of conditionality. Absolutism as a semantic tendency in humans involves, of necessity, one- or few-valued attitudes, the lack of conditionality, and thus represents a pre-human tendency.

To what extent the language of the *degrees of conditionality* is helpful in understanding the development of *human* 'intelligence', and why a fully developed *human* 'mind' should be related with *fully conditional* reactions of higher order, can be well illustrated by an example taken quite low in the scale of life.

This example is selected only because it is simple, and illustrates an important principle very clearly. We know that fishes have a well-developed nervous system, do not possess a differentiated cerebral cortex; but experiments show that they can learn by experience. If we take a pike (or a perch) and put it in a tank in which some minnows, its natural food, are separated from it by a glass partition, the pike will dash repeatedly against the glass partition to capture the minnows. After a number of such dashes it abandons the attempt. If we then remove the partition, the pike and the minnows will freely swim together and the pike will not attempt to capture the minnows.⁴

The dash for capturing the minnows was a positive and unconditional, inborn feeding reaction, unsuited for the environmental conditions as they happened to be at that moment. The (perhaps) painful striking of the glass was a negative stimulus, which abolished the positive reaction—speaking descriptively—and established a negative conditional reaction, the result of individual experience, which, as we observe by the actions of the fish, is not flexible, not adjustable, and quite rigid,

one-valued, and semi-unconditional, or of low degree of conditionality, because, when the glass partition is removed, the pike swims freely among the minnows without adjusting itself to the new conditions and capturing the minnows.

A cat separated from a mouse by a glass partition also stops dashing against the glass, but this negative reaction is *more conditional*. In 'psychological' terms, the cat is 'more intelligent', *evaluates relations* better than the fish, and when the glass partition is removed, the cat captures the mouse almost immediately.

In this connection, an interesting experiment could be made, though I am not aware that it has been performed; namely, to separate the above fishes with a wire screen, which would be *visible* to the fishes, and repeat the experiments to test if the removal of a *visible* obstacle would alter the outcome of the experiment or the 'time' of the reactions. If the 'time' for capturing the minnows were reduced, this would mean that the conditionality of the reaction was increased, and so the seeing of the obstacle, or the increased power of abstraction, would play some role in it. Even humans are deceived by Houdinis. Are we so 'superior' to the 'poor fish' ?

These problems of degrees of conditionality can also be studied in the life of insects, and the works of Professor Wm. M. Wheeler, for instance, furnish most instructive material, which we have not space to analyse here.⁵

In the process of human evolution from the lowest savage to the highest civilized man, it is natural that we should pass through a period in which the primitive doctrines and languages must be revised. The newest achievements in science indicate that the twentieth century may be such a period. Even in mathematics and physics, to say nothing of other disciplines, it is only the other day that the old elementalism and two-valued semantics were abandoned. Obviously, consciousness of abstracting produces *complete conditionality* in our conditional higher order reactions, and so must be the foundation on which a science of man, or a theory of sanity and human progress, must be built.

The suggested extension of the reaction vocabulary would allow us, at least, to apply a uniform physiological language to life, *man included*. We should have a general language for life and all activities, 'mind' included, of a structure similar to the known protoplasmic and nervous structure, not excepting the highest activities. 'Mental' ills would be considered as arrested development or regression to one-, or few-valued semantic levels; sanity would be in the other direction; namely, progression conditioned by larger and larger flexibility of conditional and seman-

tic reactions of higher order, which, through ∞ -valued semantics, would help adjustment under the most complex social and economic conditions for man. The maximum of conditionality would be reached, let us repeat, through the consciousness of abstracting, which is fundamental for sanity, and is the main object of the present work, explained in Part VII.

It seems that the aggregate of inborn, almost unconditional and acquired or conditional reactions of different orders and types constitute the foundation of the nervous activities of humans and animals. The mechanism is not an additive one. A little bit of cortex 'added' involves most far-reaching differences of behaviour in life; in fact, the number of possibilities probably follow the combinations of higher order.

Higher order combinations are constructed from groups which themselves are groups. Thus, out of twenty-six letters of the English alphabet, there are probably trillions of pronounceable combinations of letters. Sentences are groups of words which are groups of letters, and their number, therefore, exceeds enormously the original trillions. Books are combinations of sentences, and, finally, libraries are combinations of books. Thus, a library is a combination of fifth order, and the number of possible different libraries is inconceivably large. As a rule, we pay little attention to combinations of higher order, disregarding the fact that even materials and the possible variety of them have some such structure.

To give an intuitive feel how combinations of higher order increase, let me quote Jevons on the simplest case, starting with 2. 'At the first step we have 2; at the next 2^2 , or 4; at the third, 2^{2^2} , or 16, numbers of very moderate amount. Let the reader calculate the next term, $2^{2^{2^2}}$, and he will be surprised to find it leap up to 65,536. But at the next step he has to calculate the value of 65,536 *two*'s multiplied together, and it is so great that we could not possibly compute it, the mere expression of the result requiring 19,729 places of figures. But go one step more and we pass the bounds of all reason. The sixth order of the powers of *two* becomes so great, that we could not even express the number of figures required in writing it down, without using about 19,729 figures for the purpose.'⁶

In actual life, the number of possibilities of higher order combinations are limited by structural and environmental conditions; nevertheless, the numbers of possibilities which follow such a rule increase surprisingly fast.