PART II

GENERAL ON STRUCTURE

The relativity theory of physics reduces everything to relations; that is to say, it is structure, not material, which counts. The structure cannot be built up without material; but the nature of the material is of no importance. (147)

<div align="right">A. S. EDDINGTON</div>

Structure and function are mutually related. Function produces structure and structure modifies and determines the character of function. (90)

<div align="right">CHARLES M. CHILD</div>

These difficulties suggest to my mind some such possibility as this: that every language has, as Mr. Wittgenstein says, a structure concerning which, *in the language,* nothing can be said, but that there may be another language dealing with the structure of the first language, and having itself a new structure, and that to this hierarchy of languages there may be no limit. Mr. Wittgenstein would of course reply that his whole theory is applicable unchanged to the totality of such languages. The only retort would be to deny that there is any such totality.

(456) <div align="right">BERTRAND RUSSELL</div>

CHAPTER IV

ON STRUCTURE

No satisfactory justification has ever been given for connecting in any way the consequences of mathematical reasoning with the physical world. (22)   E. T. BELL

Any student of science, or of the history of science, can hardly miss two very important tendencies which pervade the work of those who have accomplished most in this field. The first tendency is to base science more and more on experiments; the other is toward greater and more critical verbal rigour. The one tendency is to devise more and better instruments, and train the experimenters; the other is to invent better verbal forms, better forms of representation and of theories, so as to present a more coherent account of the experimental facts.

The second tendency has an importance equal to that of the first; a number of isolated facts does not produce a science any more than a heap of bricks produces a house. The isolated facts must be put in order and brought into mutual structural relations in the form of some theory. Then, only, do we have a science, something to start from, to analyse, ponder on, criticize, and improve. Before this something can be criticized and *improved,* it must first be produced, so the investigator who discovers some fact, or who formulates some scientific theory, does not often waste his time. Even his errors may be useful, because they. may stimulate other scientists to investigate and improve.

Scientists found long ago that the common language in daily use is of little value in science. This language gives us a form of representation of very old structure in which we find it impossible to give a full, coherent account of ourselves or of the world around us. Each science has to build a special terminology adapted to its own special purposes. This problem of a suitable language is of serious importance. Too little do we realize what a hindrance a language of antiquated structure is. Such a language does not help, but actually prevents, correct analysis through the semantic habits and structural implications embodied in it. The last may be of great antiquity and bound up, by necessity, with primitive-made structural implications, or, as we say, metaphysics, involving primitive *s.r.*

The above explains why the popularization of science is such a difficult and, perhaps, even a semantically dangerous problem. We attempt to translate a creative and correct language which has a structure

similar to the structure of the experimental facts into a language of different structure, entirely foreign to the world around us and ourselves. Although the popularization of science will probably remain an impossible task, it remains desirable that the *results* of science should be made accessible to the layman, if means could be found which do not, by necessity, involve misleading accounts. It seems that such methods are at hand and these involve *structural* and semantic considerations.

The term 'structure' is frequently used in modern scientific literature, but, to the best of my knowledge, only Bertrand Russell and Wittgenstein have devoted serious attention to this problem, and much remains to be done. These two authors have analysed or spoken about the structure of propositions, but similar notions can be generalized to languages considered as-a-whole. To be able to consider the structure of one language of a definite structure, we must produce another language of a *different* structure in which the structure of the first can be analysed. This procedure seems to be new when actually performed, although it has been foreseen by Russell.[1] If we produce a $\bar{A}$-system based on 'relations', 'order', 'structure'. , we shall be able to discuss profitably the *A*-system which does not allow asymmetrical relations, and so cannot be analysed by *A* means.

The dictionary meaning of 'structure' is given somewhat as follows: Structure: Manner in which a building or organism or other complete whole is constructed, supporting framework or whole of the essential parts of' something (the structure of a house, machine, animal, organ, poem, sentence; sentence of loose structure, its structure is ingenious; ornament should emphasize and not disguise the lines of structure)'. The implications of the term 'structure' are clear, even from its daily sense. To have 'structure' we must have a complex of ordered and interrelated parts.

'Structure' is analysed in *Principia Mathematica* and is also simply explained in Russell's more popular works.[2] The *Tractatus* of Wittgenstein is built on structural considerations, although not much is explained about structure, for the author apparently assumes the reader's acquaintance with the works of Russell.[3]

One of the fundamental functions of 'mental' processes is to distinguish. We distinguish objects by certain characteristics, which are usually expressed by adjectives. If, by a higher order abstraction, we consider individual objects, not in some perfectly *fictitious* 'isolation', but as they appear empirically, as members of some aggregate or collection of objects, we find characteristics which belong to the collection

and not to an 'isolated' object. Such characteristics as arise from the fact that the object belongs to a collection are called 'relations'.

In such collections, we have the possibility of *ordering* the objects, and so, for instance, we may discover a relation that one object is 'before' or 'after' the other, or that A is the father of B. There are many ways in which we can order a collection, and many relations which we can find. It is important to notice that 'order' and 'relations' are, for the most part, empirically present and that, therefore, this language is fit to represent the facts as we know them. The structure of the actual world is such that it is *impossible* entirely to isolate an object. An *A* subject-predicate language, with its tendency to treat objects as in isolation and to have no place for relations (impossible in complete 'isolation') , obviously has a structure not similar to the structure of the world, in which we deal *only* with collections, of which the members are related.

Obviously, under such empirical conditions, only a language originating in the analysis of collections, and, therefore, a language of 'relations', 'order'. , would have a *similar structure* to the world around us. From the use of a subject-predicate form of language alone, many of our fallacious anti-social and 'individualistic' metaphysics and *s.r* follow, which we will not analyse here, except to mention that their structural implications follow the structure of the language they use.

If we carry the analysis a step further, we can find relations between relations, as, for instance; the *similarity of relations.* We follow the definition of Russell. Two relations are said to be similar if there is a *one-one* correspondence between the terms of their fields, which is such that, whenever two terms have the relation P, their correlates have the relation Q. and vice versa. For example, two series are similar when their terms can be correlated without change of order, an accurate map is similar to the territory it represents, a book spelt phonetically is similar to the sounds when read, .[4]

When two relations are similar, we say that they have a *similar structure,* which is defined as the class of all relations similar to the given relation.

We see that the terms 'collection', 'aggregate', 'class', 'order', 'relations', 'structure' are interconnected, each implying the others. If we decide to face empirical 'reality' boldly, we must accept the Einstein-Minkowski four-dimensional language, for 'space' and 'time' *cannot be separated empirically,* and so we must have a language of *similar structure* and consider the facts of the world as series of *interrelated ordered events,* to which, as above explained we must ascribe 'structure'. Ein-

stein's theory, in contrast to Newton's theory, gives us such a *language, similar in structure* to the empirical facts as revealed by science 1933 *and common experience.*

The above definitions are not entirely satisfactory for our purpose. To begin with, let us give an illustration, and indicate in what direction some reformulation could be made.

Let us take some actual territory in which cities appear in the following order: Paris, Dresden, Warsaw, when taken from the West to the East. If we were to build a *map* of this territory and place Paris *between* Dresden and Warsaw thus:

Actual territory   *———————*———————*
                         Paris   Dresden   Warsaw

Map   *———————*———————*
                      Dresden   Paris   Warsaw
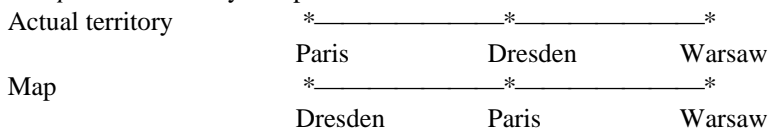
we should say that the map was wrong, or that it was an incorrect map, or that the map has a *different structure* from the territory. If, speaking roughly, we should try, in our travels, to orient ourselves by such a map, we should find it misleading. It would lead us astray, and we might waste a great deal of unnecessary effort. In some cases, even, a map of wrong structure would bring actual suffering and disaster, as, for instance, in a war, or in the case of an urgent call for a physician.

Two important characteristics of maps should be noticed. A map *is not* the territory it represents, but, if correct, it has a *similar structure* to the territory, which accounts for its usefulness. If the map could be ideally correct, it would include, in a reduced scale, the map of the map; the map of the map, of the map; and so on, endlessly, a fact first noticed by Royce.

If we reflect upon our languages, we find that at best they must be considered *only as maps.* A word *is not* the object it represents; and languages exhibit also this peculiar self-reflexiveness, that we can analyse languages by linguistic means. This self-reflexiveness of languages introduces serious complexities, which can only be solved by the theory of multiordinality, given in Part VII. The disregard of these complexities is tragically disastrous in daily life and science.

It has been mentioned already that the known definitions of structure are not entirely satisfactory. The terms 'relation', 'order', 'structure' are interconnected by implication. At present, we usually consider order as a kind of relation. With the new four-dimensional notions taken from mathematics and physics, it may be possible to treat relations and structure as a form of *multi-dimensional order.* Perhaps, theoretically, such a change is not so important, but, from a practical, applied,

educational, and semantic point of view, it seems very vital. Order seems *neurologically simpler* and more fundamental than relation. It is a characteristic of the empirical which we recognize directly by our lower nervous centres ('senses'), and with which we can deal with great accuracy by our higher nervous centres ('thinking'). This term seems most distinctly of the organism-as-a-whole character, applicable both to the activities of the higher, as well as lower, nervous centres, and so *structurally* it must be fundamental.

The rest of this volume is devoted to showing that the common, *A*-system and language which we inherited from our primitive ancestors *differ entirely in structure* from the well-known and established 1933 structure of the world, ourselves and our nervous systems included. Such antiquated map-language, by necessity, must lead us to semantic disasters, as it imposes and reflects its *unnatural* structure on the structure of our doctrines and institutions. Obviously, under such *linguistic* conditions, a science of man was impossible; differing in structure from our nervous system, such language must also disorganize the functioning of the latter and lead us away from sanity.

This once understood, we shall see clearly that researches into the structure of language and the adjustment of this structure to the structure of the world and ourselves, as given by science at each date, must lead to new languages, new doctrines, institutions. , and, in fine, may result in a new and saner civilization, involving new *s.r* which may be called the scientific era.

The introduction of a few new, and the rejection of some old, terms suggests desirable structural changes, and adjusts the structure of the language-map to the known structure of the world, ourselves, and the nervous system, and so leads us to new *s.r* and a theory of sanity.

As words *are not* the objects which they represent, *structure, and structure alone,* becomes the only link which connects our verbal processes with the empirical data. To achieve adjustment and sanity and the conditions which follow from them, we must study structural characteristics of this world *first,* and, then only, build languages of similar structure, instead of habitually ascribing to the world the primitive structure of our language. All our doctrines, institutions. , depend on verbal arguments. If these arguments are conducted in a language of wrong and unnatural structure, our doctrines and institutions must reflect that linguistic structure and so become unnatural, and inevitably lead to disasters.

That languages, as such, all have some structure or other is a new and, perhaps, unexpected notion. Moreover, every language having a

structure, by the very nature of language, reflects in its own structure that of the world as assumed by those who evolved the language. In other words, we read unconsciously into the world the structure of the language we use. The guessing and ascribing of a fanciful, mostly primitive-assumed, structure to the world is precisely what 'philosophy' and 'metaphysics' do. The empirical search for world-structure and the building of new languages (theories), of necessary, or similar, structure, is, on the contrary, what science does. Any one who will reflect upon these structural peculiarities of language cannot miss the semantic point that the scientific method uses the only correct language-method. It develops in the *natural order,* while metaphysics of every description uses the reversed, and ultimately a pathological, order.

Since Einstein and the newer quantum mechanics, it has become increasingly evident that the only content of 'knowing' is of a *structural* character; and the present theory attempts a formulation of this fact in a generalized way. If we build a $\overline{A}$-system by the aid of new terms and of methods excluded by the A-system, and stop some of our primitive habits of 'thought' and *s.r,* as, for instance, the confusion of order of abstractions, reverse the reversed order, and so introduce the natural order in our analysis, we shall then find that all human 'knowing' exhibits a structure similar to scientific knowledge, and appears as the *'knowing' of structure.* But, in order to arrive at these results, we must depart completely from the older systems, and must abandon permanently the use of the 'is' of identity.

It would seem that the overwhelming importance *for mankind* of systems based on 'relations', 'order', 'structure'. , depends on the fact that such terms allow of an exact and 'logical' treatment, as two relations of similar structure have all their logical characteristics in common. It becomes obvious that, as in the A-system we could not deal in such terms, higher rationality and adjustment were impossible. It is not the human 'mind' and its 'finiteness' which is to be blamed, but a primitive language, with a structure foreign to this world, which has wrought havoc with our doctrines and institutions.

The use of the term 'structure' does not represent special difficulties when once we understand its origin and its meanings. The main difficulty is found in the old A habits of speech, which do not allow the use of structure, as, indeed, this notion has no place in a complete A subject-predicativism.

Let us repeat once more the two crucial *negative* premises as established firmly by *all* human experience: (1) Words *are not* the things

we are speaking about; and (2) There *is no* such thing as an object in absolute isolation.

These two most important *negative* statements cannot be denied. If any one chooses to deny them, the burden of the proof falls on him. He has to establish what he affirms, which is obviously impossible. We see that it is safe to start with such solid *negative* premises, translate them into positive language, and build a $\overline{A}$-system.

If words *are not* things, or maps *are not* the actual territory, then, obviously, the only possible link between the objective world and the linguistic world is found in *structure, and structure alone.* The only usefulness of a map or a language depends on the *similarity of structure* between the empirical world and the map-languages. If the structure is not similar, then the traveller or speaker is led astray, which, in serious human life-problems, must become always eminently harmful, . If the structures *are similar,* then the empirical world becomes 'rational' to a potentially rational being, which means no more than that verbal, or map-predicted characteristics, which follow up the linguistic or map-structure, are applicable to the empirical world.

In fact, in structure we find the mystery of rationality, adjustment. , and we find that the whole content of knowledge is exclusively structural. If we want to be rational and to understand anything at all, we must look for structure, relations, and, ultimately, multi-dimensional order, all of which was impossible in a broader sense in the *A*-system, as will be explained later on.

Having come to such important *positive* results, starting with undeniable *negative* premises, it is interesting to investigate whether these results are *always* possible, or if there are limitations. The second *negative* premise; namely, that there *is no* such thing as an object in absolute isolation, gives us the answer. If there is no such thing as an absolutely isolated object, then, at least, we have two objects, and we shall *always* discover some relation between them, depending on our interest, ingenuity, and what not. Obviously, for a man to speak about anything at all, *always* presupposes *two* objects at least; namely, the object spoken about and the speaker, and so a *relation* between the two is always present. Even in delusions, illusions, and hallucinations, the situation is not changed; because our immediate feelings are also un-speakable and *not* words.

The semantic importance of the above should not be minimized. If we deal with organisms which possess an inherent activity, such as eating, breathing. , and if we should *attempt to build for them conditions*

where such activity would be impossible or hampered, these *imposed* conditions would lead to degeneration or death.

Similarly with 'rationality'. Once we find in this world at least potentially rational organisms, we should not *impose* on them conditions which hamper or prevent the exercise of such an important and inherent function. The present analysis shows that, under the all-pervading aristotelianism in daily life, asymmetrical relations, and thus structure and order, have been impossible, and so we have been *linguistically* prevented from supplying the potentially 'rational' being with the means for rationality. This resulted in a semi-human so-called 'civilization', based on our copying animals in our nervous process, which, by necessity, involves us in arrested development or regression, and, in general, disturbances of some sort.

Under such conditions, which, after all, may be considered as firmly established, because this investigation is based on undeniable *negative* premises, there is no way out but to carry the analysis through, and to build up a $\overline{A}$-system based on *negative* fundamental premises or the denial of the 'is' of identity with which rationality will be possible.

Perhaps an illustration will make it clearer, the more that the old subject-predicate language rather conceals structure. If we take a statement, 'This blade of grass is green', and analyse it only as a statement, superficially, we can hardly see how any structure could be implied by it. This statement may be analysed into substantives, adjectives, verb. ; yet this would not say much about its structure. But if we notice that these words can also make a question, 'Is this blade of grass green ?', we begin to realize that the *order* of the words plays an important role in some languages connected with the meanings, and so we can immediately speak of the structure of the sentence. Further analysis would disclose that the sentence under consideration has the subject-predicate form or structure.

If we went to the objective, silent, un-speakable level, and analysed this objective blade of grass, we should discover various structural characteristics in the blade; but these are not involved in the statement under consideration, and it would be illegitimate to speak about them. However, we can carry our analysis in another direction. If we carry it far enough, we shall discover a very intricate, yet definite, relation or complex of relations between the objective blade of grass and the observer. Rays of light impinge upon the blade, are reflected from it, fall on the retina of our eye, and produce within our skins the feeling of 'green'. , an extremely complex process which has some definite structure.

We see, thus, that any statement referring to anything objective in this world can always be analysed into terms of relations and structure, and that it involves also definite structural assumptions. More than that, as the only possible content of knowledge and science is structural, whether we like it or not, to *know* anything we must search for structure, or posit some structure. Every statement can also be analysed until we come to definite structural issues. This applies, however, with certainty only to significant statements, and, perhaps, not to the various noises which we can make with our mouth with the semblance of words, but which are meaningless, as they are not symbols for anything. It must be added that in the older systems we did not discriminate between words (symbols) and noises (not symbols). In a $\overline{A}$-system such a discrimination is essential.

The structure of the world is, in principle, *unknown;* and the only aim of knowledge and science is to discover this structure. The structure of languages is potentially *known,* if we pay attention to it. Our only possible procedure in advancing our knowledge is to match our verbal structures, often called theories, with empirical structures, and see if our verbal predictions are fulfilled empirically or not, thus indicating that the two structures are either similar or dissimilar.

We see, thus, that in the investigation of structure we find not only means for rationality and for adjustment, and so sanity, but also a most important tool for exploring this world and scientific advance.

From the educational point of view, also, the results of such an investigation seem to be unusually important, because they are extremely simple, *automatic* in their working, and can be applied universally in elementary education. As the issue is merely one of linguistic structure, it is enough to train children to abandon the 'is' of identity, in the habitual use of a *few new terms,* and to warn them repeatedly against the use of some terms of antiquated structure. We shall thus eliminate the pre-human and primitive semantic factors included in the structure of a primitive language. The moralizing and combating of primitive-made metaphysics is not effectual; but the habitual use of a language of modern structure, free from identity, produces semantic results where the old failed. Let us repeat again, a most important point, that the new desirable semantic results follow as *automatically* as the old undesirable ones followed.

It should be noticed that terms such as 'collection', 'fact', 'reality', 'function', 'relation', 'order', 'structure', 'characteristics', 'problem'. , must be considered as *multiordinal terms* (see Part VII), and so, in general ∞-valued and ambiguous. They become specific and one-valued

only in a given context, or when the orders of abstractions are distinguished.

In the following enquiry an attempt to build a science of man, or a *non-aristotelian system,* or a theory of sanity, is made, and it will be necessary to introduce a few terms of new structure and to abide by them.

Let me be entirely frank about it: the main issues are found in the *structure* of language, and readers who are interested in this work will facilitate their task if they make themselves familiar with these new terms and use them habitually. This work will then appear simple, and often self-evident. For those other readers who insist on translating the new terms with *new structural implications* into their old habitual language, and choose to retain *the old terms* with *old structural implications* and old *s.r.* , this work will not appear simple.

Examples illustrating what has just been said abound; here I shall mention only that the $\bar{E}$ geometries, the new revision of mathematics originated by Brouwer and Weyl, the Einstein theory, and the newer quantum mechanics. , have similar main aims; namely, to produce *non-el* statements which are structurally closer to the empirical facts than the older theories, and to reject those unwarranted structural assumptions which vitiated the old theories. The reader should not be surprised to learn that these new theories are not a passing whim of scientists, but represent lasting advances *in method.* Whether these attempts at restatements are finally found to be valid or not, they remain steps in the right direction.

It is quite natural that with the advance of experimental science some generalizations should appear to be established from the facts at hand. Occasionally, such generalizations, when further analysed, are found to contain serious structural, epistemological and methodological implications and difficulties. In the present work one of these empirical generalizations becomes of unusual importance, so important, indeed, that Part III of this work is devoted to it. Here, however, it is only possible to mention it, and to show some rather unexpected consequences which it entails.

That generalization states: that *any* organism must be treated as-a-whole; in other words, that the organism is not an algebraic sum, a *linear* function of its elements, but always *more* than that. It is seemingly little realized, at present, that this simple and innocent-looking statement involves a full structural revision of our language, because that language, of great pre-scientific antiquity, is *elementalistic,* and so singularly inadequate to express *non-elementalistic* notions. Such a point

of view involves profound structural, methodological, and semantic changes, vaguely anticipated, but never formulated in a definite theory. The problems of structure, 'more', and 'non-additivity' are very important and impossible to analyse in the old way.

If this generalization be accepted—and on experimental, structural, and epistemological grounds we cannot deny its complete structural justification—some odd consequences follow; that is to say, odd, as long as we are not accustomed to them. For instance, we see that 'emotion' and 'intellect' cannot be divided, that this division structurally violates the organism-as-a-whole generalization. We must, then, choose between the two: we must either abandon the organism-as-a-whole principle, or abandon accepted speculations couched in *el* verbal terms which create insoluble *verbal* puzzles. Something similar could be said about the distinction of 'body' versus 'soul', and other verbal splittings which have hampered sane advance in the understanding of ourselves, and have filled for thousands of years the libraries and tribunes of the world with hollow reverberations.

The solution of these problems lies in the field of structural, symbolic, linguistic, and semantic research, as well as in the fields of physics, chemistry, biology, psychiatry. , because from their very nature these problems are structural.