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THE DECLINE OF CONCEPTUAL THINKING

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Sir William Hamilton once said, in an unusually pessimistic mood, "The word 'concept' used to be common among the English philosophers, but as usual our lexicographers have ignored it," or words to that effect. His reflection would not be out of place today in a wider context. We are all familiar with the word, although in reputable philosophical circles it has a slightly old-fashioned ring, and a good definition is extremely hard to find. It is perhaps significant that the philosophers in whose recent work the idea is most fully dealt with have repute in other fields as well as in philosophy—Henry Margenau, for instance, is also an outstanding physicist, and F. S. C. Northrop an expert on law and international affairs. The handful of others who have paid serious attention to the matter include Herbert Dingle and Ernst Cassirer but hardly one of the growing school of logical empiricists.

This last statement may be challenged, for the word "concept" is still met with frequently, even in the works of the logical empiricists. How then can a title like the present one be justified? Is it intended to convey the idea that thought itself is changing and works on a different principle now from that on which it used to work? No, that would be too sweeping a claim and too hard to defend. That the word "concept" has gone out of use? No again, for it is, as I say, still often met with. Rather my thesis is this: that the concept as an active category in philosophy, as a useful tool in the understanding of our ways of thought, seems to be less in evidence now than almost ever before, in spite of the survival of the word. In this paper I want to examine some of the reasons for this, and to see whether perhaps there may not still be something to be gained by paying attention to concepts.

I

Concepts have a long history, although the highest point in their career probably came with Kant and the 19th-century rationalists. They constitute one of the simplest and most accessible philosophical categories, for it is easy to recognize them introspectively. From the earliest days of philosophy men realized that in their minds were entities that had a certain independence or autonomy, strangely like entities outside their minds that were apparently themselves independent of mind. One might have seen a man in a dream, knowing full well that no "real" man was there; and one knew that "real" men moved about behind one's back and during one's hours of sleep. Here was one problem: in what form did the dream men exist? And there was another: how was one in the first place able to bring all men under the category "man," when they were obviously independent of one another and of one's self? Plato's answer is well known; there exists, he said, a "form" of a man in whose image all actual men are made, and the mind in some sense has access to the form and can measure newly-encountered individuals by its standard.

This is a simplified view of Plato. But the form was the lineal ancestor of the concept, and may be held responsible, I think, for many difficulties in the history of the later idea. In Plato's time metaphysics was not the *bête noire* of philosophy that it has since become, and there was nobody to tell him that propositions about forms were meaningless. The postulation of a form as something actually existing was justified in view of the degree of organization it conferred on many other existing things. Later the concept fulfilled the same function of organization, and there clung to it some of the existential flavor of the form, which is still a good reason in the minds of many for keeping clear of it. The first notion of which we must rid ourselves is this one, that the concept is an entity existing independently of mind, duplicating in the external world the object or quality of which it is the concept. Aristotle made the form more a function of the thing itself: everything had form on the one hand and matter on the other, but the form was not dissociated from the individual and given independent existence. The form here had a kind of particular objectivity later found in the concept which appeared in English in the 17th century and was regarded as the "quiddity" of a thing, its "that-ness". One could say that an object was *that* rather than something else because of its concept. This was the formulation given by Harvey in his *New Philosophy.*

I hope I may be forgiven for rushing in this superficial way through the history of philosophy. At any rate the 18th century explored further this relation of the thing to thought. Locke did not require the concept in the way in which we require it, for he was content to suppose that our ideas are copies of external objects and to that extent like them. Berkeley did not require it either, for he believed that external objects are merely projections of our ideas, and therefore even more like them. It was left to Kant and the 19th century to realize how the external is modified in its subjection to observation, how the nature of mind itself imposes its categories on the given. Our own sphere of activity was limited on both sides by Kant. We are ectypal intelligences busying ourselves with phenomena. On the other side of phenomena are the things-in-themselves, to which we have no access; beyond our intelligences lies perhaps the archetypal intelligence of God, who sees things as they are. In the absence of the real thing, the noumenon, we have to make do with concepts *(Begriff)* put together out of phenomena.

Here is the central importance of the concept. Our physical state circumscribes us and holds us away from the world; everything the world can say to us has to cross the barrier of perception. We stand inside, looking out of the window, whose frame is a conceptual frame and will influence all that passes through it. To the extent that this is so, the world is invented by us, and concepts of things and events in it are functions of our rationality. There seems to me nothing very desperate about this; it is simply an admission of our finitude. Not many of us aspire to archetypal intelligence, and without that the only way in which the world can be made understandable is in conceptual terms. Kant said many other things, of course, not all of them convincing, but this part of his argument seems to me highly persuasive.

The rationalistic movement of the 19th century was, as I have said, the most fertile environment for the concept. Since then, however, nearly all the major movements in philosophy have laid their emphasis on other things. Epistemology itself has suffered something of an eclipse. There have been two divergent paths in the last hundred years, one heading for a highly-colored ontology that borders on mysticism, and the other for an almost colorless logic that practically merges with mathematics. The one trend obviates the concept in making direct contact with the world, and the other ignores it in the construction of formal systems. I talk in extremes and make things sound worse than they are, but I think my meaning will be plain. From the idealism of Hegel derive indirectly the existential anguish of Kierkegaard, the metaphysical Power of Nietzsche, the dialectical materialism of Marx; these are epistemologically very weak, unless one considers them strong enough not to need epistemology. Along the same lines lie the phenomenology of Husserl, with its declared abandonment of conceptual thinking, and the philosophy of Heidegger and the modern existentialists. In the other direction Moore sets the tone by his preoccupation with common sense and the common-sense meanings of words, Russell and the younger Whitehead by their concern with logic and the formalism of mathematics, Peirce and Dewey with their pragmatic criteria of truth; it remains for Ayer, Carnap, and others to carry the battle entirely into logical analysis. Here epistemology is sidetracked; and if the concept can escape the dreadful epithet "metaphysical" it may still be silenced effectively by calling it "psychological."

This is the decline of which I speak—the disregard, in the excitement of other enquiries, of what may still be one of the most useful ideas in philosophy. During the period since the beginning of the analytic movement, the concept has had to be kept alive by the people who use it, namely the scientists; and it is in scientific philosophy, itself becoming more and more influenced by analysis, that the reader may most often find it referred to. Unfortunately the scientists have not always known how best to deal with their ideas philosophically; and this explains the remarkable incursion into science, in recent years, of philosophers anxious to help their more awkward scientific brethren. These philosophers have not always been very well trained in science, but this has not prevented them from carrying aloft large banners proclaiming liberation from metaphysics.

Perhaps the principal defect in the approach of these helpers has been this: that they have reckoned too little with the aspect of science that is an art, with the nature of scientific theory as an organism. Analysis is an operation that can be practiced best on something passive and static, like dissection on a corpse. If one is content with a purely retrospective view this is all right—indeed at times one has to stop and consolidate, and a logical analyst is a good person to have about at such moments. He will prowl around with the tools of his trade—with criteria of confirmability and meaningfulness— and test the newly-erected structure to see if it is sound. But he does not always give the best advice when it is a question of adding on the next bit, and this is what scientists are continually having to do. There is an analogy here that I have found illuminating, which appropriately enough makes a comparison between science and language. (Such a comparison is one of the strong points of logical empiricism.) Sapir, the philologist, speaks of the "formal genius" of a language, meaning by this the nuances conveyed in its literary works that must inevitably be lost in any translation. I think that science has overtones of this sort, detectable only by those who have become familiar with it through close association over long periods. Now it is a striking fact that most of the celebrated philologists of the English tongue have been Scandinavians or Germans. They can see the structure of the language all right, and their reflections fill large volumes; but those of us who have been brought up on English still feel that we perhaps understand the literature better, and do not expect the philologists to make very good creative writers or even critics. Scientists sometimes feel this way about philosophers. They are just a little like foreigners who come in and make profound and worthy contributions in important areas; they are welcomed and admired, but still the suspicion remains that they have not quite touched the heart of the matter.

II

What is this element of science that eludes formal analysis? The admission of its existence seems to be edging us in the direction of metaphysics, for its empirical meaningfulness does not begin to satisfy the criterion in the same way that the meaningfulness of other propositions in science does. The reason for this is not far to seek, for now the question does not simply involve a physical situation under observation by a scientist, but rather a scientist, confronted with a physical situation, under observation by a philosopher. The point that has to be made here is that science itself is not in the external world, but in the minds of scientists—exclusively there. Only with an understanding of the nature and locus of scientific theory shall we be able to account for the failure of logic to catch its living essence. The subject-matter of scientific theory derives, truly enough, from the external; but there is more to theory than that.

We ought therefore to spend a little time on this question of the nature of theory—not, I hope, to repeat mechanically what has already been said by others, but to point to a view which may provide room for the "artistic" quality of science, the quality which allows a good scientist to dispense with the mathematical formalities of his theory and approach a new situation with an intuitive confidence bred of long experience. In experimental work J. J. Thomson was famous for his ability almost to sense what slight changes would have to be made in order for an experiment to be successful, much as a really great artist is able to point out exactly what is wrong with a painting although the fault may elude a good deal of painstaking analysis by others; and there are many other examples of this kind of thing in science. Scientific philosophers as a rule concentrate on the formal aspect of theory. Norman Campbell describes theory as a set of propositions, or really as two sets of propositions, one called the "hypothesis" and one the "dictionary". Rudolf Carnap deals with it in terms of two languages, the observation language and the theoretical language. Now this aspect of the matter is of the greatest importance, since the usefulness of a theory is a function of its communicability, and the preferred mode of existence of theories, when not under consideration by scientists, is in books. Gaston Bachelard indeed has attempted to make this kind of reality a separate category alongside phenomenal reality. He says: "The philosopher speaks of phenomena and noumena. Why doesn't he pay attention to existence by means of a book, to the *bibliomenon?* To exist by a book is after all a form of existence, and such a human existence, such a thoroughly human one!"[1] This provides a very neat way of speaking about "a theory" as a unitary or monolithic structure, and it can be handled and seen and sent from place to place in a highly convenient fashion.

But books without readers are empty things. A theory in a book is a series of meaningless marks unless somebody pays attention to it. When finally somebody does pick up the book, there is still no guarantee that he will understand what it says; yet all the sentences are there, and the symbols in them are defined, and the relations between the symbols set out in order. Why does he not understand it? How are we to answer this? He does not know what the symbols mean. So in turn we are driven to a brief investigation of meaning.

Leaving aside emotive meaning we may make a broad distinction between two principal kinds of meaning, namely those which have been called "sense meaning" and "linguistic meaning" by C. I. Lewis.[2] Lewis defines linguistic meaning as "the intension of an expression as that property which is common to all expressions which could be substituted for the one in question without altering the truth or falsity of any statement." This leads from symbols to more symbols, to words, perhaps; the reader may now be able to translate what the book says into terms more familiar to him. The stage he has now reached may be one at which he says: "Yes, I see what it means, but it still doesn't make sense." This is a far more common reaction in the learning of science than some philosophers may suppose. In this case the symbols—or some of them at least—must be invested with sense meaning. Lewis's definition of sense meaning is "intension as a *criterion in mind,* by reference to which one is able to apply or refuse to apply the expression in question in the case of presented, or imagined, things or situations." Here at last the student has a chance to link what the book says to his experience, and the theory takes on a firm intelligibility where before it hung in the air.

Now are we to say that the theory, as understood by the student, resides entirely in the language that expresses it? Surely not. Language, much as it has influenced thought, is itself a later arrival in the mind; and it is possible to have sense meanings which do not depend on language at all, but rather on pre-linguistic ideas. In order for an animal, for instance, to have a criterion in mind whereby it may judge whether a certain type of plant forms a part of its usual diet or not, it is certainly not necessary for it to have a word or any sort of linguistic symbol in mind. And in fact sense meanings, even for comparatively well-developed intellects like our own, may often be couched in not dissimilar mental processes, and only linked with the symbol when the matter comes up explicitly. Consider for example a man who sees a rock falling off the cliff above him: the word "dangerous" may not necessarily come into his mind, although he will proceed to act in all respects as if the word applied to the situation, as indeed it does. The meaning of the state of mind he finds appropriate to the situation is exactly the same, with respect to the criterion of applicability, as the meaning of the term "dangerous" which he would use if he were to describe it in words.

It will be clear by now what I am getting at. The necessity has arisen here for something non-linguistic to fill out theory for the individual mind, and the obvious candidate for the position is the concept, which, if admitted, turns theory from a kind of pseudo-language into a conceptual system. This definition of theory is the one to which I would at the moment give strongest support. But like all positions philosophers advocate, this one entails consequences which ought to be explored before it is made the basis for further development. I have already discussed some of the shortcomings of logical analysis as a universal procedure in scientific philosophy, although it may be as well to stress again that I make no question of its usefulness, only of its exclusiveness. It has, however, one great advantage, namely that language is public, while concepts, if we are to avoid metaphysics, are not. This problem must be got over somehow. There are two ways of approaching it; one is to see whether the language of science is really as reliable as it seems, and the other to seek some method of rendering the concepts public.

III

Mathematical languages are essential to modern science, because quantitative work cannot be conveniently handled with any other tool. Accordingly the student, whose first approach to science is frankly conceptual, has gradually to accustom himself more and more to thinking in terms of integrals, series, functions, and the like. This in itself for many scientists constitutes a sort of private decline of conceptual thinking. But it is at the boundary between the conceptual and the purely mathematical or formally symbolic that the greatest barrier to the progress of understanding is encountered. It is like crossing a bridge, the first part of which is paved and forms a firm highway, and coming to a point where only girders, and slippery ones at that, stretch into the distance towards the opposite shore. People with a stomach for heights—or for mathematics—can complete the crossing safely, but the others simply stand and gaze after them in admiration. The provision of a valid philosophy of science in mainly conceptual terms would be like paving the rest of the bridge.

It seems to be the opinion of many that this cannot be done, because any filling-in of the framework would be a falsification in some sense of the state of affairs. No *one* conceptual interpretation of the mathematics will suffice; therefore we had better stop with the framework and be thankful that we have any means of crossing at all. But what often is not realized is that the formal structure itself, mathematics and theoretical language together, is a function of the conceptual schemes of the men who pioneered it. In a recent article John Rader Platt points out that chance may alter the whole shape of a mathematical science. Had Zeeman had a better spectroscope when he discovered his famous effect, says this writer: "Neither Lorentz nor anyone else would then have believed that there were intact electrons, all alike, inside the atom; perhaps fractional ones would have been assumed. The Bohr atom would have been different, or impossible. Quantum mechanics as we know it might never have appeared. No doubt some other theoretical system would have been produced in its place, but by now, after fifty years, its practitioners would speak a language incomprehensible or perhaps unbelievable to our best physicists."[3] So that not even the framework of the bridge is the only possible one—indeed it seems to be about as arbitrary as a conceptual filling-in might be. One cannot even be sure that logical empiricists would have found the same philosophical pattern if another path had been followed. It is interesting in this connection to observe that three quite different mathematical techniques have been adopted by Dirac, Heisenberg, and Schrodinger to deal with a subject for which one conceptual scheme might suffice, thus turning the tables, as it were, on the mathematics.

On the other hand, is there no way out of the subjectivity of the concept that might restore its philosophical usefulness? There are two approaches which seem to show promise. The first consists, not in the rendering public of particular concepts, but in the rendering common of certain parts of conceptual schemes, creating as it were an isomorphism between the scientific structures in the minds of several individuals. The result of such a process would be an identity of function between concepts, rather than an identity of form, whatever that might signify. In this way certain difficulties of a "monolithic" theory of theories would be avoided. Some philosophers have held that theories are such closely-knit entities that one proposition, if disproved, will lead to their downfall, an extension of the argument that a chain is no stronger than its weakest link. I doubt whether this is a very useful approach. It makes of science something too perfect, gives it in fact a perfection most scientists would hardly dream of striving for. It is enough for them if the area that particularly concerns them is clear and if they can agree about it with other workers in the same field. The philosopher, seeking an inclusive view, admits that the details are left to others; he does not see the practical snags, the changes in conceptual approach that have to be made by individuals in order to get over particular hurdles. As a rule the scientist does not have time for the architectonics of science—he is too busy tracking down sources of noise, or devising monitors for his counters, or keeping out unwanted bacteria, or adjusting his microscope, or chasing the coefficients of his Bessel functions. But he can understand science very well as a combination of many conceptual systems like his own, some overlapping his, others in quite different areas. The most faithful view of scientific theory is, it seems to me, to regard it as a sum of conceptual schemes actually held by many individuals, no two the same, but each being wholly or partially isomorphic with a number of the others, and each coherent with all the rest, although this again is an optimum condition. Such a structure is certainly much more flexible than a monolithic one, and there seems no reason in principle why it should not be made the basis for a completely satisfactory account of science.

The other way of getting the concept out of its subjectivity involves quite different considerations. Work has been proceeding rapidly in recent years on the neurological bases of thought, and we are now in a position to exhibit what may be the actual mechanism of conception. The work of Warren McCulloch and Walter Pitts is of special interest, because they have been able to establish specific links between certain kinds of neural activity and the knowledge of universals. It has long been understood that the reception of external stimuli through the sense organs leads to activity of some kind in the cortex. Early research in this field led to a hypothesis favorable to behaviorism. It was thought that what happened was something like this: a stimulus arriving at a sense-organ or receptor "fired" an afferent peripheral neuron (that is, caused the passage of an electrical impulse through a cell leading into the cortex); this stimulus was then conveyed linearly, through the successive firing of further neurons in the cortex, to an efferent peripheral neuron which energized an effector. Such an event is a simple exhibition of stimulus-and-response. Now Warren McCulloch and other neurologists view the cortex as a highly intricate "net" of neurons, which are arranged, not only in the linear patterns referred to above, but in circuits. Some of these circuits may be made to reverberate; that is to say, an impulse originating at a receptor may be fed into a circular path and travel round it indefinitely if the time for completion of one circuit is longer than the time required to restore the status quo in any particular neuron after it has been fired. McCulloch illustrates this by setting up an imaginary ring of dominoes standing on their ends, so that when one is pushed it knocks down the next, and so on round the circle.[4] If there is a mechanism for setting each domino up as soon as it has been knocked down, so that it is standing again by the time the one behind it falls, then this action will go round and round continually until the restoring mechanism fails. Herein resides a possibility of memory; instead of the simple stimulus-response situation, the original impulse is stored and may be effective much later.

Space does not permit elaboration of this subject; in any case it ought to be expounded by a specialist. But the consensus of opinion among the neurologists themselves gives ground for hope. McCulloch and Pitts have shown that the principle of reverberating neural circuits may be extended to the recognition of universals (which they call "trapped universals"), like timbre of a sound independent of pitch, or squareness and other geometrical forms independent of size; they have also indicated how the cortex may coordinate different appearances of an object as seen in different perspectives. Other workers have indicated that memory is established in at least two senses: one analogous to the McCulloch-Pitts reverberating circuits, and the other involving an actual change in the state of one or more neurons during the execution of these circuits. The latter has been compared to the development of a photograph; although time is required for it to be established, once the impression has been made it is much more permanent than the reverberating-circuit type of memory; it may even remain when the reverberating-circuit type has become much weakened, as is observed commonly in old people. J. Z. Young of London, who may stand as an authority on the subject, says that "we have good sound reasons for believing that both the cycles of activity and the printing on the brain really occur."[5]

This is not philosophy, but it has its implications for philosophy. If a machinery for conceptual thought can become a part of science, there is provided a reflexive support for the theory that science itself rests on conceptual bases. It remains for me to indicate how scientific theory might be built up on such a foundation, and what implications for philosophy in general might appear in theory so constructed.

IV

In this attempt I shall disregard entirely the definitions of the concept given by contemporary scientists and philosophers, most of which are too vague or too restrictive. Two examples may serve to illustrate this. Herbert Dingle says, "Concepts are creations of reason for the purpose of correlating experience,"[6] which is very vague indeed. What is a "creation of reason"? What is "reason"? I do not say the sentence is meaningless, but I do not find it very useful. P. W. Bridgman says, "The concept is a set of operations,"[7] which is very restrictive. And what is a set? One can hardly avoid the suspicion, sometimes, that in the effort to drive metaphysics out of science, philosophers have invented categories which, if closely examined, prove to be more metaphysical than ever.

My point of departure lies in the two functions of the cortex in correlating stimuli, which may be called two aspects of the concept. The first is the provision of criteria for the recognition of objects or situations previously encountered, the establishment, in Lewis's terms, of sense meanings. Neurologically this is done by setting up reverberating circuits and networks of circuits, which filter incoming impulses and channel them into certain preferred "regions" of the cortex. (I do not mean to say that these regions are always spatially localized, for information about this is still uncertain.) The second is the imprinting upon the mind of certain representations of perceptual events. Of course these need not be visual images, or anything of the sort; they are simply permanent visual effects *corresponding* to visual experiences, tactile experiences, and the like.

I still have not pointed out the nature of the relation between the vivid, sensed event and the neural event that corresponds to it. This I cannot do; and if I could it would be no use discussing it with other men because I have no guarantee at all that my vivid, sensed events are anything at all like theirs. This is a kind of subjectivity from which there is no escape; each of us resides in a world of his own. That is why in order to have any guarantee that we all do have concepts we must treat our own minds as objects of scientific study. The concept as a state of affairs in the cortex is the only one we can use as a common basis for discussion.

But once given that concepts, in this sense at least, do exist, we may easily recognize in them the two aspects I have referred to: the criterion for recognition of something, and the representation of it. It is possible to think of a man although there is none to be seen, but the image called up in the process has to submit to the same criterion of recognition as a real man would if one happened to come along. This representative (not always a visual image, of course) is not always present to the mind (if it were, there would be a serious problem of overcrowding), but when it is present it submits to the criterion.

Even the simplest concepts have to be learned. The neural net of the newborn corresponds remarkably to Locke's *tabula rasa;* the organization of the circuits is a matter of experience, and the synaptic links are originally "chaotic." When a child opens its eyes and is presented with what James called a "booming, buzzing confusion" or what Northrop calls the "undifferentiated aesthetic continuum" it has no established circuits that would enable it to respond intelligently to the situation. Certain motor responses are present, and the pattern of the net is in a sense determined, too—chaos lies in the relations between parts of it. Out of this chaos emerges, slowly, the immediately-apprehended world of the non-scientist. The learning process is a consequence of the juxtaposition of the individual and the activity of the external, a situation in which stimuli are constantly being encountered. Once they start to crowd in, the cortex need not be idle.

Some stage such as this is, I suppose, as far as animals ever get. They at least must live in a world of concepts by intuition, to use Northrop's language; they have no means of formulating deductive theories, which are the basis for another category of concepts by postulation. But this particular division has its difficulties. Northrop introduced it to account for a difference in modes of thought between East and West; but if it were to be useful at all, I suspect that it would only be to draw a distinction between man as an animal and man as man.

The difference in modes of thought that impresses me is that between man as man and man as scientist. On a pre-scientific level the conceptual scheme soon becomes influenced, not simply by Nature, but by other men; and the incoming stimuli include written and spoken language, signs and the like. The provision of language makes very much simpler the response to many situations and enriches the conceptual scheme enormously. Still we are not to suppose that as soon as language enters the door, more primitive concepts fly out of the window, or even that they retire to a corner and become moribund. Even scientists still have them and make use of them in their less scientific moments.

But the organization of knowledge that language, and especially mathematical language, makes possible does lead to important consequences. A man can exert a reflexive influence on his own concepts and make changes in them with a view to simplifying his notion of the world or bringing it into closer harmony with events. This process marks the beginning of science, and it furnishes a basis for distinction between scientific concepts and non-scientific ones. A familiar name for the former is *construct,* denoting a concept deliberately changed or modified in order to provide a better interpretation of the sensed world. Constructs as so defined may of course appear in other fields of inquiry besides science, but this paper is particularly concerned with scientific ones. Scientists are aware of ways in which mass, for example, as used in the equations of mechanics, has a different significance from mass as used to refer to an indeterminate lump of material. The first is a construct, because it has been circumscribed and disciplined with scientific ends in view; the second is one of the concepts common to most men, scientific and otherwise.

The word construct, too, occurs in the literature. Sometimes it seems to be interchangeable with concept, sometimes not; certainly no general agreement on this usage exists. I think part of the trouble lies in the fact that nobody is quite sure where the construct is, whether it is supposed to be in the external world or somewhere else. This leads to arguments about whether it is better to call certain things in physics "constructs" or "inferred entities," because if they are constructs then we must have put them where they are, and they can do nothing without our approval, and thus science is rendered sterile; while if they are inferred entities they may really be there after all and perhaps be caught doing new and exciting things. Constructs are said to have only systemic existence, while inferred entities may have real existence; and systemic existence has the unfortunately paralysing effect I have just referred to. But such an interpretation of the situation shows a misunderstanding of the way in which science works. It has significance only if one makes analysis the whole of scientific philosophy, for then indeed there is no room for novelty within the system. In fact, however, few scientists have ever placed such a value on the formal structures of their systems as to make them inflexible. Something may have for us only systemic existence, but the interpretation of experimental data may lead us to revise the system itself.

A construct, then, is a concept deliberately modified with a view to the erection or improvement of a scientific theory. The usefulness of the construct is clearly determined by the other constructs together with which it forms a theory. If the theory is a mathematical one, for instance, then the constructs must all submit somehow to measurement. And they must certainly still, like the concept, have reference to the perceptual situation from which all theory derives. *Reality,* for the moment, remains shrouded.

The definition of a construct will naturally be a good deal more precise than that of a concept, and the representative aspect of it will be even less like a visual image than was that of the concept. Yet theories built of constructs do not always prove to be wholly successful, and of recent years paradoxical situations have arisen in which no construct derived (as ours are) from concepts can give an intelligible account of what is happening, and in which theory has been compelled to cut across what appeared to be immutable boundaries. Consider for example the familiar case of the electron. The conceptual basis for the original construct "electron" was a particle; but in 1927 electrons were detected behaving like light-waves, being diffracted, in fact. There was no obvious way of reconciling these two constructs, wave and particle; physics went boldly ahead and treated the electron as if it were both, and the popular imagination had to content itself with a mental picture of a schizophrenic "wavicle." This word was coined by Sir Arthur Eddington, with the famous suggestion that the electron behaved like a wave on Mondays, Wednesdays, and Fridays but like a particle on Tuesdays, Thursdays, and Saturdays.

V

Now this situation seems to call for another category; and the name I use for it is the "isolated construct," or more simply the "isolate." The isolate is a construct regarded *purely* as a function of the theory of which it forms part. Theory having been established as a system the validity of any part of which is judged on the basis of its coherence with the rest, the conceptual basis of the construct can be discarded if it leads to conflict. If theory says that the isolate "electron" can be described by the equations characteristic of particles and also by those characteristic of waves, we accept its finding, and do not distress ourselves over the fact that the two are conceptually irreconcilable. We have to trust theory and let the isolate hang from it, as it were, not expecting it to have a direct foundation in concepts. The theory as a whole will still have conceptual bases—otherwise it would be incomprehensible. But a surprising number of them can be and have been done away with, principally because all our concepts necessarily have their genesis in the macroscopic world, and it turns out that there is not strict isomorphism between processes in that world and in the microscopic and astronomical worlds. There are ways of rendering isolates intelligible in conceptual terms, but such ways have to be used carefully. No isolate appears directly in perception (the lack of a perceptual link constitutes its isolation), but electrons, for instance, do produce cloud-chamber tracks. A track in fact consists of small drops of water that have condensed on ionized gas molecules, and the passage of the electron is a deduction from a knowledge of the process of ionization. On the one hand, then, there is an immediately-sensed event, the cloud-chamber track, and on the other a theoretically-designated concept by postulation, the electron. It is then easy to establish a correlation between the two, and say that the cloud-chamber track in the sensed world corresponds to the passage of an electron regarded theoretically. This kind of stipulative connection has been called an "epistemic correlation" by Northrop. Another way of making isolates vivid, by analogy, is the provision of *models* for systems involving them. A model for a system whose elements are isolates is an analogous system of which the elements are constructs (and therefore imaginable), and which has the property that the relations between the constructs are of the same form as the relations between the isolates in the original system. Bohr's model of the atom pictures electrons bearing the same relation to the nucleus as the planets bear to the sun. The usefulness of the model depends on the degree to which the mathematics used to describe its behavior can be used to describe the behavior of the original system. What has constantly to be borne in mind, however, is that the model, however useful, can never *replace* the system it helps to describe.

Now if the understanding of isolates requires such devices, what is the justification for them? What, in any case, is the relation of this scheme that I have outlined to the *real* world, if any such thing exists? This is the time, I think, at which to tie all this together by outlining the kind of philosophy that seems to me appropriate to the situation.

First of all, in my view, there is an external world that we have not constructed; it was there before we were born, and it will be there after we die. It is orderly, it is causal, it is in process, and we interact with it; this is all we can say of it— nothing more. These are bold statements, and I had better try to justify them immediately.

Beginning with the simple conceptual scheme of an individual, a pattern something like this exhibits itself: Sensations arrive, without volition, from somewhere outside; the manner of their arrival is orderly—an order which the individual interprets as spatial and temporal. On the basis of experience the mind—again without volition—arranges its concepts in an order corresponding to that which exhibits itself in the sensations. There is no one-to-one spatial relation, of course, in most cases; nevertheless the order of the concepts reflects the order of the sensations. The two realms have a similarity of form; they are *isomorphic.* With his conceptual apparatus the individual can now make his way successfully among the obstacles of the world of sensation. As his education progresses he acquires language, another system exhibiting isomorphism both with the conceptual scheme and with the world of sensation. If he becomes a scientist (or a specialist of any kind) he adds another, more restricted system of constructs which might be called selectively isomorphic with the other three; and finally he finds it necessary to place some isolates, not having corresponding elements in perception, in the interstices of the system of constructs.

Still this says nothing about reality. No, but consider now how such a remarkable similarity of form among all these systems can have arisen. Remember that it all stems from the stimuli coming in uninvited from the external, and all bears a pattern not of our invention. Remember also that it is not simply a question of the schemes of one individual, but of many; and the possibility of communication between these individuals indicates an isomorphism there too, all of it derived from the same sort of perceptual situation. Does this not force us to postulate a natural reality, a world of being? Not necessarily, you may say: perhaps the isomorphic systems just hang together that way. All of them are in mind; they constitute a universe of thought, and that is a universe some of us are content to inhabit. The reason why it seems to me sensible to postulate a universe of being, as distinct from such a universe of thought, is that in principle the universe of thought could be entirely capricious, and it is not. The simplest explanation of the constancy of form between the isomorphic systems is to suppose the existence of another system isomorphic with all of them—such that they are all imperfect isomorphs of it—underlying them and proceeding independently of them. This system must be orderly, for it dictates the order of the others; it must be in process, for the others are not static; it must interact with us, because somehow its order has been communicated to our mental processes. And it must be causal, because it fulfills predictions which we make about it on the basis of causal laws; and if the prediction breaks down, it is the law we alter and not the order of natural reality. This causality certainly cannot reside in perception, which is constantly interrupted, and if it were our own invention we would have no way of making it efficacious. It characterizes the link between states of natural reality which appear to us in perception as cause and effect.

The isolate, then, while it does not correspond to an element of perception, may still correspond to an element of natural reality. Further speculation on the nature of this ultimate reality soon degenerates, and meaning criteria perform a real service in bridling it. Even the little I have said may be too much. Science does well to restrict its attention to what gives promise of solution. The charge may indeed be made that the conceptual system I have outlined lacks precision and is therefore bad philosophy. But it seems to me significant that in the history of philosophy the arrival of precision in any field has always signalled the breaking-away of that field from philosophy proper and its establishment as an independent discipline. Logic perhaps is heading in that direction now. At any rate I do not feel that any apology is in order for a lack of logical exactness; the reason why man has progressed so far is that his thought processes have a certain flexibility and will not submit to rigid formalization.

The scheme I have been speaking of is to be regarded as suggestive and not in any sense rigid. The more intelligent a man is the greater will be his conceptual grasp and the less explicit theorizing (involving constructs) will he have to do; and on the other hand, the more complex the theory he uses, the greater will be the demand it makes on this enriched conceptual scheme, and the more new constructs will he have to devise. The boundary between concept and construct fluctuates slowly, however, for the individual, and is not hard to draw in particular cases although no ultimate objective criteria may be attainable. At all events I think the distinction a useful one, and I believe that the freer use of these categories in a critical manner might help to liberate some contemporary students of philosophy from the linguistic cobwebs in which they tend to become entangled.

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[1] Gaston Bachelard, *L'Activité Rationaliste de la Physique Contemporaine* (Paris: Presses Universitaires de France, 1951), p. 6.

[2] C. I. Lewis, *An Analysis of Knowledge and Valuation* (LaSalle, Ill.: Open Court, 1947), Chap. VI.

[3] John Rader Platt, "Style in Science," *Harper's Magazine,* October, 1956, p. 74.

[4] Warren McCulloch, *Finality and Form* (Springfield, Ill.: Thomas, 1952), p. 21.

[5] J. Z. Young, *Doubt and Certainty in Science* (Oxford University Press, 1951), p. 82.

[6] Herbert Dingle, *Through Science to Philosophy* (Oxford, 1937), Appendix.

[7] P. W. Bridgman, *The Logic of Modern Physics* (New York, 1927), p. 3.