15th January 1953

Lecture Eight.

Living Beings.

Though knowing can never be strictly impersonal and therefore, strictly speaking, such fact-stating sentences as "it rains" or "Napoleon is dead" make no claim to knowledge unless they are asserted by someone, yet knowledge can be embodied to a considerable extent in the operations of a formalism. This process of depersonalisation is limited by the fact that a formalism can be used properly only by persons who clearly understand it and that it will be chosen for use only by persons who appreciate its intellectual felicity. Further personal factors enter when a scientific formalism referring to experience is brought to bear on experience. Even in the exact sciences where this is done by measurements in which the part played by skill and connoisseurship is reduced to a minimum, this minimum cannot be eliminated. It is clear therefore that even the mathematical sciences do not achieve strict objectivity; yet it is a fact that those sciences are usually accepted as a practical substitute for ideal objectivity by those who strive for this ideal. The objectivist disregards sceptical scruples in respect to exact science and limits his programme to the formulation of all empirical knowledge in terms of such science. I myself have lent support to this restricted conception of objectivity by acknowledging the existence of exact observations capable of verification, as the limiting case of validation in which validation becomes virtually impersonal.

I have shown in the Lecture on Chance and in the Lecture on Order, that statements of probability and theories of setting up _a priori_ idealisations, like the system of crystallography, are modes of evaluating experience which are not readily corrigible or not corrigible at all by experience. I have gone on to describe the performance of skills by which we fashion coherent actions and the exercise of connoisseurship by which we identify and grade complex entities. I have thus introduced a whole panorama of personal knowledge referring to personal facts and in my last lecture I have tried to show why these personal facts are and must always remain unspecifiable in detail. I have shown in particular that the coherence of wholes and the meaningfulness of the parts of these wholes within the context of the wholes, can exist only if sustained by an intelligent personal effort of an integrating mind. They are mentally formed by two kinds of awareness, one subsidiary the other focal, which can be présent only in the mind of a person whose attention is fixed on a focal fact by subsidiarily attending to its particulars.

In my present lecture and the two others that are to follow, I propose to show that all our knowledge of living beings is of a personal kind; that life in all its inexhaustible manifestations is a personal fact, in the sense which I have given to that term in these lectures.

Such an affirmation must inevitably evoke - but evoke in a new form - the old controversy whether biology can become an exact science; whether life can be exhaustively represented in physical and chemical terms. Indeed, in view of what has been said before about the unspecifiability of personal knowledge ~~it~~ the affirmation that life is a personal fact would deny any such possibility altogether.

At the same time the old question now reappears within a wider perspective, for it arises in the same form for all manner of personal knowledge, including a wide range of instances referring to inanimate objects. We would expect that any exact observations made on things of which we have personal knowledge without reference to the context sustained by our personal knowledge will be without any interest and that if pursued with the overt or tacit claim of giving an exhaustive account of the subject matter, such observations are bound to dissolve our previous knowledge of these things, leaving us with a mass of irrelevant particulars in its place.

Take first our personal knowledge of chances. When a pair of dice is in the air, I can say that the chance that the throw will result in a double six is 1/36. But if I could observe the exact position and the velocities of the dice in the air, and the elastic and other mechanical properties of the table on which they will fall, the outcome of the throw would be predictable and the notion of alternative chances would cease to be applicable; for we could no longer guess what we already know. Similarly, the temperature of a gas of which we knew the precise molecular configuration would become meaningless. A knowledge of the chances of a throw, or of the temperature of a gas, could be reconstructed from the exact data of the particulars only by some process of neglecting the particulars by averaging over their values which would suppress most of our knowledge of the particulars. At any rate, we could lift the blindness caused by our exact knowledge of atomic particulars only by discovering some processes by which the particulars can be brought to bear on such personal facts as the probabilities of a throw of dice or the thermal properties of a gas, as observed previously without knowledge of the exact particulars of the system.

Psychologists have adopted the term 'molar' for denoting certain comprehensive features and the term 'molecular' for an exact detailed picture of the system having these features. I shall use the terms 'molar' and 'molecular' in a more general way, calling 'molar features' those that I am shaping or understanding by personal knowledge, and calling 'molecular data' the results of a comprehensive set of exact observations of the same subject matter. This identifies the ideal of exact science with that formulated by Laplace when claiming that from a complete list of molecular ~~functions~~ positions and velocities, combined with a comprehensive knowledge of molecular forces, we could predict the whole future and past of the universe. It would appear from what I have said so far, that such a prediction would actually tell us almost nothing, for it could hardly throw light on the molar properties which alone mean something to us.

However, this is clearly not the last word on this matter. The application of exact methods to subjects that we had previously observed only by tests of personal connoisseurship has been acknowledged by my own account of technological research and the value of such sciences as biochemistry and biophysics cannot be doubted for a moment. The question can only be how the methods of exact science are to be applied to such complex subjects and where exactly lie the limits beyond which they cannot be taken. I shall try to find an answer to this question by taking an example which reveals the essential points, without bringing in all the mysteries of life.

Let us consider mechanical devices like clocks, sewing machines, typewriters or jet-engines, and let us call for the moment the class of such artefacts briefly 'machines'. I can identify a thing as a machine only if I believe that it works, which includes the assumption of a purpose which it achieves in working, and no purpose can be said to exist unless I either share it or consider it to be reasonable for some other person. Self propelled machines have movable parts constituting an internal context of their own, but nevertheless the context of the machine must be taken to include its purpose together with the person who entertains the purpose. A sequence of cause and effect occurring in a machine can be accredited within this context as an orderly running of the machine or alternatively condemned as a defective manner of operation.

When a machine is in good working order it presents an instance for the operational principle which would characterise it in a patent. The principle of a machine describes how each of its parts fulfils its function by acting upon another as a means for achieving the purpose of the machine. The law of patents acknowledges the invention of a new machine when its principle is first clearly formulated or when it is first put into practice. It recognises the originality of this act by acknowledging that its product is the personal property of the inventor and is entitled to protection by patent.

The same machine can be constructed from the most varied materials and in so different shapes and sizes that only a close analysis will identify these machines as embodiments of the same principle. A patent which attempts to cover all conceivable embodiments of a mechanical principle will avoid therefore mentioning the physical or chemical particulars of any actually constructed machine except insofar as these particulars are essential to the operation of the principle. Just as the rules of algebra will operate for any set of numbers for which the algebraic constants of the equation can stand, so the operational principle of a machine is valid for any particulars which are covered by its general terms and such a principle must be stated, therefore, like the rules of algebra, at the highest possible level of abstraction. Only such a statement can correctly define the machine as a molar entity.

Suppose now that instead of a statement of its operational principle we were given a complete molecular knowledge of a machine, for example of a particular pendulum clock, and equipped with the mental powers for computing all its future molecular configurations. It is obvious that such a picture would not tell us anything about the working and use of the clock nor of any other machine to which it may apply. It would not even indicate the distinctive parts of which a machine is constructed, so that the machine would dissolve altogether into a meaningless aggregate of data.

This would be equally true of any set of exact observations made on a machine without some anterior understanding of its operational principle. No such observations can in themselves distinguish whether a machine is working well or badly nor, consequently, can they ever constitute a statement of its correct operations. Therefore, they necessarily ignore its operational principle and can have no bearing on it as a machine.

If we wish to make use of physical or chemical observations in order to deepen our understanding of a machine, for example of a clock, we must have previously guessed or at least surmised that the clock was a time-keeping instrument and have some intimation of the functions performed by its various parts, as of the weights which drive it, the pendulum which controls its speed by rhythmically releasing the escape and the hands which indicate the passage of time. We could then go on to verify these operational elements and gain a more precise insight into them by the aid of physical and chemical observations, suggested by this context. This should subsequently enable us to improve on the operational principle of the clock and perhaps transform it from a household timekeeper into an instrument of precision for the use of astronomers.

I have said that the molar features from which we must start and by which we must continue to be guided in the study of a machine must be given to us by a personal understanding of the machine which recognises its operational principle and appreciates its purpose. But this supposed knowledge may be fallacious. The wheel of perpetual motion described by the Marquis of Worcester in 1663 was falsely supposed by him to be kept in motion by the succeeding descents of the weights attached to its rim. The project of such a machine can be analysed in terms of its supposed operational principle and its fallacy exposed. Alternatively, we may subject to exact physical and chemical scrutiny a particular apparatus for which false claims are being made and expose its fraudulence or absurdity. And again, an erroneous analysis may mistakenly contradict true claims. When dealing with the critical analysis of crafts I have mentioned cases which illustrate both these eventualities by analogy. (My analysis of homoeopathic cures claimed to be a true refutation of a false craft while the analysis of 'piano touch' was mentioned as an example for the false refutation of a true craft). In both cases the molar framework is retained for the purposes of the analysis which - be it rightly or mistakenly - ends up by contradicting its validity. In neither case does the analysis commit the error of attempting to eliminate and to deny the reality of molar principles by analysing the subject matter of our personal knowledge in terms of exact impersonal observations.

Some physical and chemical characteristics of a machine, such as its weight, size and shape or its fragility, its susceptibility to corrosion or to damage by sunlight will be of interest in themselves on certain occasions, for example to a carter undertaking the transportation of the machine. But this is about as much as the study of a machine by exact impersonal observations can achieve in itself.

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We enter the domain of even more pronounced incommensurabilities between the molar and the molecular aspects of a subject matter if we pass on from machines to such human artifices as printed words, maps, arithmetical computations or a game of chess. The physical and chemical particulars of the objects functioning as words, maps, etc. are in themselves quite obviously insufficient to convey our personal understanding of them and any attempt to represent these objects in terms of these data would blatantly ignore their meaning. The interrelation between the molar and the molecular aspects of these objects is so insignificant that it cannot be so clearly appreciated as in the case of machines. The analysis of machines makes therefore a more apt introduction to the study of living beings, in the pursuit of which molecular data can be extensively and significantly related to molar features. But as soon as we refer to living beings, we develop an important additional feature in the structure of our personal knowledge. To this I shall now turn.

Life does go on in tissue cultures and viruses which are not segregated in the form of individuals and the germ plasma transmitting heredity also presents a continuously extended form of life that transcends the individuals through which it passes. In plants and the lower animals like protista, hydrozoa and worms, many different parts of an individual are viable in themselves and to this extent the individuality of the parent organism is blurred. But apart from these instances of not or only incompletel individualised life we find that the bulk of living matter is embodied in a finite set of individuals circumscribed in space and of limited duration in time. Each has come into existence at a definite moment, to remain alive for a certain period, after which it will die.

I am myself an individual being. Therefore as I gave instances of my personal knowledge, and analysed its general structure, revealing my essential participation in it, I have already been dealing with a living being, and crediting it with those arts of doing and knowing of which I believe myself possessed. I shall suggest in generalisation of this fact that the observation of plants and animals is essentially similar to that of reflecting on my own intellectual powers. Indeed, since life is always the life of a person, my knowing of life acknowledges as valid the manifestations of persons, which involves a twofold personal structu First, there is the personal character of my knowledge. This is apparent in the fact that it refers to a kind of orderliness in the shape, function and behaviour of a living organism which sets it a standard to which I expect it to 'live up'. And secondly there is of course the personal structure of the person itself whose life I know. Its manifestations are personal in respect to its own person as they are the manifestations of its person. The same two-storied structure of our knowledge of life comes into view also by another important approach. When I recognise an animal as a normal specimen, whose body functions healthily and whose behaviour shows proper intelligence, I assess its shape, its internal processes and its manner of action from its own point of view, just as I would criticise its shape as malformed, its functions as diseased or its behaviour as incoherent, in relation to what it normally ought to be, not in order to please me but to be properly of its own kind. In this sense my personal understanding of a living organism must necessarily share its life as a person, and in this sense again, knowledge of a person is always of a two storied structure.

This twofold structure is particularly marked if we take the case when a psychologist studies the process by which an animal learns something, for example to recognise a sign. The psychologist classifies the animal's responses as right or wrong and watches him gradually establishing the right habit. We have here a sign-event relation on the Level Zero; then an animal discovering it on Level One, and thirdly a psychologist observing the process of discovery on Level Two.

At the lower levels of life there is no separation into logical levels of a person and the manifestations of the person; yet even so the personal knowledge of life remains always distinct in respect to its logical structure from a personal knowledge of inanimate molar features, for in a rudimentary form it carries already in itself the two-storied structure which at a higher range of the observed person's manifestations separates out into three distinct logical levels.

The further elaboration and the effective application of the foregoing logical analysis must be postponed to the next two lectures which will deal with the characteristic activities of life. For before approaching that range of subjects I have yet to face the fundamental morphological fact that every living individual has a recognisable shape, which characterises it as the member of a particular species.

This typical shape is often quite obvious. The law which punishes murder, recognises this act in the wilful killing of any living being of human shape. We know the wide variations to which the human shape is subject; according to age and race; through malformations and mutilations; through diseases which may shrivel the body or swell it and distort it; by malignant excrescences weighing many pounds. Yet the law acknowledges these widely different shapes as belonging to the same recognisable human type and indeed demands that everyone should recognise them as such and beware that he does not kill their bearer. Nor does this demand appear excessive since one has not heard of a case in which an accused had pleaded failure to recognise the human character of something he had killed. We invariably know a human being when we see one.

Yet it would seem impossible to devise a definition which would cover the whole range over which human shape may vary, and it is certain that those who recognise it are not in possession of any such definition. Instead they have a belief that humans exist and they continue to build up their awareness of the human type by noticing individual human beings. The process is of the same kind by which our focal awareness of a molar feature is generated from a subsidiary awareness of its parts. We have seen how the attention by which we concentrate on this focal meaning may assimilate further parts of it which fit into the whole without our ever noticing the act except in the corresponding modification of the comprehensive feature to which it contributes.

This process of morphological abstraction is more effectively displayed when it does not occur as a matter of course but by the exceptional gifts and special training of a naturalist. Famous among these was Sir J.D. Hooker who in 1859 brought together and published evidence of nearly 8000 species of flowering plants in Australia more than 7000 of which he had himself collected. Each of the types that he identified represented a generalisation from a variety of different specimens and the correctness of Hooker's generalisation has since been borne out in the vast majority of cases by subsequent observations and are believed by botanists (whose judgment I accept) to represent real entities. The recognition of a definite set of generic entities from many thousands of varied individual specimens requires unusual insight. "Few ever have known or ever will know plants as he did," wrote Hooker's biographer in 1913. The personal character of the knowledge embodied in the identification of a species was clearly revealed in the contributions to the Fifth International Botanical Congress of 1930 held in Cambridge partly for the purpose of finding a definition for a species. Thus Professor C.H. Ostenfeld responded to the problem of the Congress by stating emphatically that a species consists of all the individuals the character of which are in all main points the same so far as the characters which we consider essential are concerned." It is obvious that the 'we' in this definition refers neither to the speaker alone nor to the whole of mankind, but to skilled botanists accredited as such by the speaker. A.S. Hitchcock revealed the situation more frankly by saying "The concept of most species must rest on the judgment and experience of the individual botanist". To this extent our knowledge of a species is unspecifiable and therefore unverifiable. It claims either a personal understanding of a complex physiognomy or a personal appraisal of another person's capacity for understanding such a physiognomy.

A species is of course defined in each case by certain distinctive key features, which facilitates the subsequent identification of a specimen as belonging to a particular species; but this presupposes our anterior acceptance of the suggested key as the true characteristic of a species. For the choice of a feature as key feature would not establish a species! Moreover, the key features themselves are variable in shape and reference to them represents once more a claim to the recognition of a typical shape which transcends these variations. We cannot escape this by reference to the characteristic details of the key since this would merely shift the problem to a further stage. It is unavoidable that ultimately the anatomy of a species should rely on reference to details which are not further specified in detail, and since these ultimate details will still be manifestly variable such knowledge as we claim to have of them must rest on our estimate of what are things of the same type in different forms. When key features of plant species are characterised by different authors as ovate, oval, lanceolate, hirsate, ciliate . . . " said A.T. Wilmot at the Fifth International Congress of Botany, they may have quite different attributes in mind. For the meaning of these terms is the product of an extensive process of generalisation over a series of variable instances which were different and was evaluated somewhat differently by different botanists.

And again the personal knowledge of physiognomies depends on the use of an appropriate personal skill. You have no effective knowledge of a particular detail of anatomy - say the anterior tibial artery in man - unless you can isolate it yourself by dissection, and this requires a delicate and not specifiable skill. This is perhaps more clearly illustrated on the example of clinical symptoms. In order to judge the quality of a pulse you must know how to feel for it. Similarly, you may hear clearly enough the changes in the percutory sounds elicited by a practised teacher of medicine, but find that you cannot reproduce them. What you do will in general determine what you observe; and no specification can define the right mode of doing.

I have spoken earlier of the use of maxims, the interpretation of which is part of an art, as a guide to the practice of an art. The knowledge of a systematic key plays the part of a maxim in the identification of specimens; it is useless to a person not trained in the art of identifying the key features within a comprehensive unspecifiable pattern of the whole. In any case, the identification of specimens in the field may often successfully dispense with the observation of any key features when these are located inside the specimen's body.[1]

The geneticist would tend to restrict the conception of a species to a group within which cross-fertilisation produces fertile offspring (comp. e.g. Harland 1935), but this criterion can be applied only to a small fraction of the material which has been classified into morphological species. It has confirmed this classification in numerous cases and thus added to its weight, yet at the same time it sets up a more impersonal standard which challenges the scientific value of the personal assessment of species according to typical shapes. But any attemtp to ignore the immense wealth of knowledge established by the naturalist on account of its personal character would be merely a yielding to the objectivist obsession~~x~~ which would ban every responsible act of our intelligence.

When a botanist examines a flowering plant with a view to associating it with a few other specimens he has collected before and discriminating it from all others he has ever seen, for the purpose of characterising a new species to which the plant belongs, his observation of the plant is subsidiary to his striving to characterise its species. But as he comes across more numerous specimens of the plant this process will gradually change its character; for once the character of the species is well established any single additional specimen will no longer noticeably modify its conceptions. Just as an explorer who first travels through a country with a view to establishing its geography, will use his

1. Comp. F.C.A. Pantin "The Recognition of Species", (manuscript, May 1952).

knowledge of it later for finding his way through it, so the taxonomist, having once established his system will use it for the identification of new specimens under its categories. There is the same shift of focal interest in both cases in the relation between experience and a conception of experience, resulting from the fact that the conception has become relatively fixed.

The analogy will be made complete if we represent a system of species by a set of type-specimens of the kind kept in museums as a guide to the identification of flowers or insects. The collection of type-specimens in the British Museum is used internationally as a taxonomic standard. It was reported for example on 5th November 1951 that "American zoologists found a strange flea in Utah and sent it to Dr. Carl Jordan, the British Museum expert for opinion. Dr. Jordan confirmed the Utah flea as a new species".[1] In thousands of other cases type specimens are found to identify the specimen sent in for opinion. We may put down therefore as parallels A and B

(A) $\dfrac{\text{Taxonomist exploration}}{\text{Observations in the field}} \xrightarrow{\text{indicates}}$ collection of type specimen

$\dfrac{\text{Taxonomist identification}}{\text{collection of type specimens}} \xrightarrow{\text{identifies}}$ new specimen

(B) (1) $\dfrac{\text{Geographical exploration}}{\text{observation of traveller}} \xrightarrow{\text{indicates}}$ map of a region

(2) $\dfrac{\text{Geographical guidance}}{\text{map of a region}} \xrightarrow{\text{identifies}}$ place in which traveller finds himself.

The arrows point always towards the focus of interest. This has its formal expression in the fact that one formal system can be mapped out in terms of another and that the same holds in reverse if the two systems are isomorphous.

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1. (Manchester) Evening Chronicle, 5 November 1951.

But at this point there comes into view the essential difference between Case A and B, which consists in the fact that each type specimen stands for an experience of a large number of varied individual specimens the subsidiary awareness of which is the type specimen's true meaning. That is why only experts with wide experience can use type specimens correctly for the purpose of recognising an unidentified specimen.

The identification of a specimen differs therefore from the identification of a hill top with a small triangle on a map or even with the geographic conception of the hill top, for it identifies the specimen with a conception which carries an organised subsidiary awareness of a large number of more or less similar specimens. The ensuing asymmetry becomes apparent if we write down the progression

(1) n specimens $\xrightarrow{\text{indicate}}$ type specimen (species forming)

(2) type-specimen $\xrightarrow{\text{identifies}}$ (n+1)-st specimen. (naming)

(3) n+1 specimens $\xrightarrow{\text{indicate}}$ type specimen (species forming.)

(4) type specimen $\xrightarrow{\text{identifies}}$ (n+2)nd specimen ... etc. naming.

Each line describes the merging of specimens into a comprehensive entity, but while in 1, 3 . . . etc. our focal attention is on the ensuing modification of the entity, in 2, 4, . . . etc. it is on the new specimen which is being interpreted in terms of the entity in its hitherto established form. Whether the concept of the species is the fact under examination as in 1, 3 . . . or is used as an interpretative framework as in 2, 4 . . . , the process is always the merging of molecular facts into a molar entity by an act of personal judgment.

I have dwelt on the structure of morphological species in detail because it is the prototype of the way in which a concept and a name come to stand for many instances and are used in their turn to denote new instances. But I must return now once more specifically to the nature of my knowing the shape of a living being in which I shall include later also my knowledge of growth and function.

The observation of individual shapes sets up a standard of shape in the light of which an individual specimen can be criticised from its own point of view. The growth and vital functions of an organism can also be appreciated only in the light of what is considered normal for it. Life on the vegetative level is actuated by no extroverted drive and consequently we cannot value in such forms of life any external achievement but merely a manner of existence. In this vegetative life resembles a work of art, for it aims, like a work of art, only to achieve stable coherence according to its own peculiar scheme.

To know a form as satisfying in itself is to admire its beauty. Only the naturalist who loves plants and animals will acquire a personal knowledge of them, and indeed unless he can contemplate them with joy he will never be able to observe them with sufficient persistence. "I confidently assert" writes Konrad Z. Lorenz[1] that no man, even if he were endowed with a superhuman patience, could physically bring himself to stare at fishes birds or mammals as persistently as is necessary in order to take stock of the behaviour patterns of a species, unless his eyes were bound to the object of his observation in that spellbound gaze which is not motivated by any conscious effort to gain knowledge, but by that mysterious charm that the beauty of living creatures works on some of us!" Another distinguished zoologist C.F.A. Pantin[2] has said more particularly that the aesthetic appreciation of animal form often leads us to the recognition of important anatomical features and Agnes Arber (The Natural Philosophy of Plant Form C.U.P. 1950, p.210) has suggested a connection between

1. "Physiol. Mechanisms in Animal Behaviour", Cambridge, 1950.

2. C.F.A. Pantin, Presidential Address to the Zool. Sect. British Association 1951.

artistic power and morphological insight in botany.

To this extent biology is "two-storied" already at the sub-personal level of its subject matter. It is sustained and guided by an appreciation of harmonious being which, like the appreciation of a work of art, is itself a manner of harmonious being. As we rejoice in the contemplation of living beings, their germination and growth and the wondrous self-sustaining functions of their organs, we feel that our own contemplation of these things is justified by their example. For our contemplation is justified only by its enjoyment of itself, ~~similarly to~~ like the life of the living things that it contemplates.

1. C.F.A. Pantin, Presidential Address to the Zool. Sect. British Association 1951.

Note to Series II, Lecture VIII, p. 18:

The Listener, June 11, 1953 –

Gavin de Beer, on the Nat. Hist. dept. – British Museum

Bicentenary of the BM – I –

p. 977: "we have 15,000,000 insects and 5,000,000 plants, and so when anything is sent to us, we have quite a good chance of matching it up to see if it is something that we know already or something new." –