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Living Action.

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The purpose of my last two lectures will be to demonstrate the transformation of our personal knowledge of inanimate things into a personal knowledge of things having themselves personal knowledge of other things. I hope to show thereby that the acknowledgment of personal knowledge in the exact sciences not only assimilated our validation of them to our validation of art, law and religious practices, but also bridges the gap between the I-It and the I-Thou relations, that is between objective manipulation and inter-responsible meeting. It is indeed with this prospect in view that I have tried to make clear that personal knowledge sets up standards of appraisal of things known, which are prominent in acts of connoisseurship and in the self-criticism necessarily accompanying the performance of skills.

At the same time, I have suggested in my last lecture that the higher molar features to which we ascend by a more ample use of personal knowledge, for example, <sup>of</sup> a machine, cannot be exhaustively analysed in more de-personalised terms such as offered by exact sciences. The analysis must be conducted in the light of the principles inherent in the molar structure of such entities and exact data can be relevant to them only if collected with a bearing to these principles.

I have so far taken only a first step along this programme by reflecting on our knowledge of the typical shape which characterises a species. I shall now bring alive this shape by recognising it in action, but at first only in such primitive forms of action as are represented by growth and the vegetative functioning of the organism, as well as perception and behaviour up to a level requiring no marked intelligence. In each case I want to make us aware of our existential contact with the centre of action within the animal and demonstrate that our understanding

of the 'action' consists in the critical assessment of its particulars in their bearing on this centre of which they thus constitute the meaning both within the animal and to ourselves as we observe it.

I shall give a few samples of the kind of knowledge that we possess of the morphogenesis of animals. Protozoa regenerate from any small piece containing a fragment of the nucleus. Ascending to multicellular types, we find that hydra and many other coelenterates are able to develop new individuals from cuttings. Certain fresh water worms (*Lumbriculus*, *Stenostomum*) may regenerate from a piece 500 times smaller than their bulk.

In higher animals we still observe the regeneration of a limb or a sense organ. Thus the arms of the squib, the eye-bearing tentacles of snails, the legs of spiders, the claws of lobsters, the lens in the newt (Cf. Weiss 459 ff.) all appendages of insects and the limbs of fish and amphibians grow again after amputation. Mammals cannot be regenerated, all that remains is only a process of continuous repair and the healing of wounds. Young animals regenerate better than old ones. The frog is unable to replace a limb whereas as a young tadpole it is able to regenerate the same member.

The sexual propagation of the higher animals may be regarded as a form of regeneration in which a new individual grows out of two fused cells of two adults of opposite sex. The embryonic stage of this growth leads up to the formation of a youthful animal which then grows into a mature individual capable of reproducing itself in its turn. The fragments detached from embryos of certain lower animals have the capacity of regenerating the whole embryo and of producing normal individuals. This ontogenetic principle was first discovered by H. Driesch in the embryo of the sea urchin. Throughout its cleavage stage any cell or combination of cells detached from the embryo will develop into a normal sea urchin. Driesch characterised these regenerative

powers of an embryo by describing it as an "harmonious equipotential" system. The apparent tendency of the germ to build up a normal embryo in spite of severe amputations is more generally referred to today as "morphogenetic regulation".

Other embryos show more firmly localized potentialities from the very first. If the fertilised Ascidian egg in the 2 or 4 cell stage is cut in two, each half develops only into half an embryo. Though this type of ontogenesis is never free of regulative tendencies, its principle can be clearly distinguished as a pattern of independently proceeding processes of growth; by which the organism is built up in sections which must fit together and be ready to function together when the moment arrives for it. Such a mosaic of independently proceeding interlocking sequences corresponds to the conception of ontogenesis which Roux and Weisman had formulated and made universally current before Driesch's observations on equipotentiality.

Speman's discovery of organisers in the ontogenesis of vertebrates presents us with a combination of both principles. He found that in the newt at the gastrula stage of the embryo there is situated at the edge of the blastopore, that is the entrance of the cavity representing the primitive gut, a region which dominates the further segmentation of the embryo. If the embryo is cut up, any part of it in which this dominant region is included or in which it is engrafted, will proceed to develop further, while in the embryonic tissue from which it is eliminated, individuation comes to a stop. Thus the dominant region, which is the seat of the organiser, moulds a whole region under its control into one complete embryo, irrespective of any otherwise predetermined character of its several components cells, which are induced to respond equipotentially to its stimulus. Equipotentiality may be extended even to the tissues of another organism belonging to a different species. Thus by grafting the organiser of a light coloured newt species (*Triton cristatus*) on the embryo of a dark coloured variety (*Triton taeniatus*) Speman and Mangold could show that some of the host's dark cells were used by the grafted

organiser to build up a second individual within the embryonic host still developing under the guidance of its original organiser.

This early equipotentiality is superseded in the further process of embryonic maturation by the formation of sub-centres of organisation. Each of these separate organisers controls the development of one section of the embryo in relative freedom from regulative influence of other parts of the embryo which are developing under the control of other organisers. The first organiser having split into a whole hierarchy of secondary, tertiary, etc. specialised sub-organisers each of these controls the development of a limb, of part of a limb or of some other organ or feature emerging from the progressive differentiation of the individual. A segregated area provided with its own organiser may be cut off with it and go on differentiating in isolation; as has been proved for the case of limb and tail buds of newts and lizards. If transplanted into the place of an amputated limb it will, after a certain maturation, still produce in this anomalous position the determinate tail. At this higher stage the development of the embryo may be regarded as a mosaic of interlocking independent sequences, each controlled by its organiser, while equipotentiality has been reduced within the narrow confines of the several regions controlled by their separate organisers.

This picture of ontogenesis, as the invasion of embryonic tissues by a multiplying array of organisers, represents the outcome as entirely determined by the action of the organisers, to which the tissues respond passively. But embryonic tissues do not always submit unconditionally to the field of an organiser. Grafting experiments have shown that "a field cannot make any cell produce any specific response unless that cell is intrinsically prepared to do so."<sup>1</sup> This preparedness is called the 'competence' of the tissue.<sup>2</sup> Indeed, the part played by the

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1. P. Weiss, Principles of Development (1939) p.359.

2. Waddington's term: See H. Speman, Embryonic Development and Induction, New Haven, 1938, p.341.

organiser may be reduced to a mere evocation of the potentialities preformed in the tissue subjected to its influence. Tissue taken from the embryo of species A (newt) may fail to produce certain features that are characteristic of species B (axolotl) when subjected to the organisers of species B; while in the reverse case, these organs will make their appearance in the engrafted tissue of species B in response to the organisers of the species A - the species which lacks that organ. Experiments of this kind have revealed a wide range of rivalry between the morphogmetric tendencies inherent in an embryonic tissue and those induced in it by the organising influence of adjacent tissues.

A comprehensive system of such rivalries was revealed by Child for the regenerative and propagative functions of hydroids and worms. *Corymorpha* is a hydroid fixed to the sea bottom by its stem on the top of which it carries its flowerlike hydrant. If a piece of *Corymorpha* stem is transplanted to another part of the stem it may dominate its environment and develop an apical region, complete with hydrant, as it would have done in isolation and in doing so reorganise the adjoining area of the host into part of the newly formed individual; but it may alternatively happen that such a graft is incorporated into the existing stem and developed as part of it. The law which will determine which of the two will happen is simple: if the piece is taken from nearer the apex and transplanted further away from it, it will become dominant and develop into a new individual; if the other way round, it will be assimilated by the existing organism. (Child, "Patterns, etc." p.293).

Child suggests that in the lower organisms we may regard every piece as striving to develop into a new individual and as restrained only by the dominance of the adjoining upper regions and ultimately by the dominance of the hydranth in the hydroids and the head in the worms. Propagation by budding and

segmentation in the tail end which is common in lower animals marks a successful local revolt against the unity-enforcing dominance of the apex. Any weakening of communication with the apex, as may be thought to occur by the continued growth of the animal's stem or tail, will release in these parts their powers of vegetative propagation.

The apex is the most sensitive and the most active part of the animals which controls their feeding. In the worms and higher animals the centre of the nervous system is prevalently localised here and it controls from here the locomotion of the body. It seems significant that the anatomical region which at higher phylogenetic stages increasingly takes charge of the co-ordinated behaviour of the body and becomes the central instrument of all its intelligent manifestations, is found possessed at the lower stages with the organising power for maintaining and restoring the shape of the animal's body.

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The process by which the regeneration of nerves takes place even in the highest animals represents a residue of the morphogenetic control exercised in the lowest animals by the apex. Growing from stumps attached to the centre, the new fibres penetrate peripherically through the tissues until they reach and attach themselves to the muscles cut off from innervation.

The foregoing brief survey contains a sufficient range of results for the characterisation of the study of morphogenesis. I shall carry forward for this purpose six statements culled from it. (1) Any small cutting of certain animals will regenerate the whole animal. (2) Any cell or group of cells detached from the embryo of certain species at the stage of segmentation may form a complete animal; in contrast to which (3) the fertilised eggs of other species appear to form a mosaic, the isolated elements of which tend to form only a segment of the complete animal. Furthermore (4) the early development of some animals proceeds under the control of a single organiser which subsequently splits up into a large number of independent sectional organisers; and (5) the morphogenetic effect of any organiser is restricted by the competence of the tissue on which it is acting so that (6) the organiser may even produce a feature found only in the species to which the responding tissue belongs and lacking in the species to which the organiser belongs.

The kind of statements which I have quoted here embody general principles which may be used for explaining how mutilated animals are regenerated or normally developed from eggs to complete individuals. These principles were derived from experimental observations undertaken largely for the purpose of gaining an insight into the normal processes of morphogenesis. In the higher animals the distinction between the study of spontaneous and experimentally conditioned morphogenesis is clearly marked. The first is known as descriptive embryology, and forms an extension of normal anatomy which starts with the description of the germ cell and leads on through the various stages of the embryo, to the completely formed individual. This series of anatomies represents the continuous expansion of a dynamic process. This is acknowledged by the terms used in

descriptive embryology to designate various sections of development. At an early stage it speaks of morphogenetic movements occurring in the form of tissue streams, later it refers to gastrulation, invagination, etc. and eventually to a vast array of differentiated proliferations by which the final individual is constituted. Thus the study of embryogenesis starts off with the acknowledgment of a comprehensive achievement as represented by the formation of a normal individual from the germ cell, and proceeds to enquire into its dynamic particulars. Descriptive embryology will comprise therefore only processes which participate in this concerted action and will characterise each particular by the contribution which it makes to the successful completion of their joint operation.

Experimental embryology studies these morphogenic processes further by an artificial variation of the conditions in which they take place. By subjecting an embryo to specific injuries, or isolating a part of it, or grafting part of it to another embryo, general principles of morphogenic action are revealed, of the kind that I have just quoted. The experimental conditions will often lead to developments that do not occur in the course of normal development. But any experimental result will invariably be appraised in terms of form achievement as illustrated by the fact that all the principles that I have quoted can be expressed only in such terms. Such principles ascribe certain capacities of form achievement to certain embryonic systems.

The experimental study of embryogenesis has been contrasted to descriptive embryology as "the science concerned with the causal analysis of development".<sup>1</sup> This is correct only if 'causal analysis' is used in a sense that would also apply to the process of finding out how a machine works. For in both cases we start with the assumption that we are faced with an achievement and then proceed to analyse the principles which may

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1. C.H. Waddington "The Epigenetics of Birds" (1952).  
Comp. also A.M. Daleq, "Form and Causality in Early  
Development" (1938).

account for it. But the causal particulars to which we advance in either case are meaningful only in their bearing on the presupposed achievement, while any exhaustive causal analysis of these systems carried out without relation to this achievement would totally dissolve our original knowledge of these systems.

Before analysing further our knowledge of morpho-  
genetic achievement, it may be useful to generalise what has been just said to other achievements of living beings, our knowledge of which is of a similar kind. The automatic functioning of our internal organs is such an achievement. It differs from morphogenesis in the first place by the fact that the changes involved in it are transitory so that the "wisdom of the body" has been acknowledged pre-eminently in its capacity for keeping its internal condition unchanged in spite of widely varying external conditions. The circulation of our blood and the process of our breathing operate at a rhythm that is counted in seconds while our digestion of food, its resorption and storage, its oxidation and the elimination of the refuse through lungs, kidneys and bowels extends over cycles of whole days and nights; but whether quick or slow, these pulses leave the animal unchanged and indeed form part of a vast system of activities, including the external behaviour of the animal which are concerted in achieving this stability.

I must attend here in passing to the argument against mechanism, which some distinguished thinkers have based on the neatly adjusted balance of organised functions. It seems to me that this has gone astray for failure to appreciate the true nature of machines. In his Gifford Lectures of 1927/1928, entitled "The Sciences of Philosophy", the late J.S. Haldane has given a fascinating account of the delicate interplay of the lungs and the kidneys, which keep the acidity of the blood at a precisely fixed level against any inflow of acid or alkali.

From examples of this kind the author concludes that "Coordinated activity is thus a fundamental characteristic of living organisms and is not explicable in terms of special mechanical structure"; and he claims that biology cannot be fully analysed in terms of physical and chemical processes. This is most confusing: for co-ordinated activity is an essential quality of a machine and it is hence that no machine can be exhaustively analysed in terms of physical and chemical processes. The conclusion reached by J.S. Haldane that biology is an 'independent science' which cannot be replaced by the exact sciences holds therefore on the very grounds contested by him. Insofar as the organism is a machine it can be analysed only in terms of operational principles and the observation of any physical or chemical processes occurring within the system can be relevant to its essential function only as an embodiment of these principles. Just as the systematic study of the operational principles embodied in machines constitutes the science of engineering which can never become a mere branch of physics, so the study of the machinelike principles embodied in a living organism cannot either be resolved into a study of physical and chemical processes.

The mistake implied in J.S. Haldane's formulation is pressed home explicitly by E.S. Russell when affirming of a machine that "its parts can be adequately characterised in terms of their own structure, apart from their relations to the machine as a whole".<sup>1</sup> On the contrary, a machine is just the kind of object the study of which must start from an understanding of its comprehensive features. E.S. Russell says elsewhere: "The proper method of the biologist is to start with the organism as a whole and work down from this to the conditions of the whole-actions."<sup>2</sup> Very true; but this would apply both to the

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1. E.S. Russell "The Interpretation of Development and Heredity" (1930) p.146.

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process of finding out how a machine works and to the analysis of an organism assumed to be a machine.

In earlier times it was precisely the machine-like functions of animals that struck man's attention as evidence of divine planning, but Darwinism has tended to efface this significance by assuming that the living machine had come into existence by cumulative strokes of luck, the result of which had been stabilised by the fact that the configuration resulting from them proved capable of functioning as machines which provided for their own maintenance and reproduction. Hence any reluctance that remained smouldering here and there against the acceptance of this mechanical framework as a complete account of the existence of life in all its forms, has turned into an inclination to look out for any shortcomings of the machinelike conception of animals. This is how the "organismic" character of living beings has become identified with any biological functions which cannot be explained as machine-like performances.

In this sense the issue is indeed real and significant and was first raised by Hans Driesch by his discovery of the remarkable fact that any fragment of the sea urchin embryo develops into a whole individual. Morphogenetic regulation remains indeed up to this day the most striking evidence of a biological purpose, being achieved not by putting into operation a preformed fixed mechanism but by the occurrence of a comprehensive process of equilibration, the final state of which coincides with the goal of a biological purpose.

These morphogenic changes prefigure other forms of goal-seeking on higher levels of living action, which by their inexhaustible improvisations seem to defy explanation in terms of a machine-like structure. I have in mind the whole multitude of integrative processes to which the Gestalt movement and writers of the organismic school, like E.S. Russell and von Bertalanffy have given prominence in every field of biology.

The importance of these processes is indeed fundamental. The great question which arises at this point is whether these biological equilibrium patterns are the manifestations of the same atomic forces which are known to us in the inanimate world, or whether they are essentially living structures due to an inherent tendency of matter to produce higher class of patterns of inanimate matter, in which molecular forces become effective which have not been manifest at lower levels of achievement.

It seems to me that only the latter conception can account for the continuity between the lowest living functions and the world of conscious strivings impelled by a multitude of cravings and guided by the sensory qualities of touch, sight and hearing, from which the whole realm of human thought and responsibility ultimately emerges. Take any such quality, for example the hearing of sound. No knowledge of acoustics can break the silence which surrounds the man born deaf. And even if he became an expert in observing the neural changes which accompany hearing in other persons' brains, he could gain no understanding of what it is they are hearing; any more than we can understand the sensations which dogs have when they hear supersonic sounds. The harmonies which we appreciate in the shapes of crystals and the stabilities which impress us in flames and eddies are qualities of space time configurations and as such they lie within the province of equilibrium patterns that can be determined (and which in these cases are determined) by the space time structure of matter. But the quality of sounds heard is not a space time configuration and can therefore not be so determined.

If the conception of living beings as equilibrium patterns ultimately determined by atomic mechanics fails to account for the wealth of sensual modes experienced by us as living beings, we may also doubt whether the characteristic shape, growth and

function of living beings can be accounted for in these terms. For the facts of morphology, morphogenesis and physiology form the matrix of our sensations and emotions - and ultimately even of our responsibilities - and they cannot be properly represented in terms which necessarily ignore the very existence of consciousness. One has only to recall how the functions of the digestive tract, of the sexual apparatus or the sense organs are interwoven with the external behaviour, with the emotions and intelligence of the animal to appreciate the extent to which physiology relies on facts of consciousness.

Once we accept the existence of structural properties of matter not manifested in atomic physics which determine the successful equilibration of living beings we shall naturally expect that ascending levels of life will reveal the manifestations of an increasing range of non mechanical principles. We may recognise the beginning of such a progression in the formation of heavier nuclei and later of stable atoms, molecules and crystals, from a primeval haze of widely dispersed protons and electrons. In these glowing primeval masses the limitations imposed by the Pauli principle on the number of electrons having the same principal quantum number could never have been discovered. Thus the principle underlying the regular electronic patterns of the heavier atoms and determining in consequence the formation of molecules and crystal lattices from these atoms, would remain unrevealed until the primeval masses had cooled down to a temperature at which greater densities of matter can permanently subsist. We would thus see coming into existence novel types of order of an immense variety, determined by an organising principle not manifested in the previous state of the Universe.

If we assume a further succession of principles coming into operation to account for the continuous enrichment and growing significance of life in the course of the phylogenetic

process, we do not thereby deny the guidance of this process by natural selection. Indeed, this may entirely determine its adaptive achievements. The latent potentialities of higher principles coming gradually into action might be expected to affect the random variations on which natural selection operates with a bias towards their own actualisation. We are familiar with such biased randomness in the tentative efforts of the creative mind, for example when the potentiality of a novel mathematical conception seems to guide the guesses of successive generations of mathematicians towards the ultimate act of its discovery. The heuristic process shows a drift of accidental impulses which survive and accumulate by a growing intimation of success. Similarly, accidental variations of the genotype, if biased towards the actualisation of higher principles would offer opportunities for a process of natural selection which would achieve continuous Darwinian adaptation within a general drift towards the realisation of higher forms of existence.

If there exists a more or less consistent process by which matter is progressively enlivened, we would expect to find that phylogenetic development tends to follow parallel lines in branches developing separately, more markedly than would be expected from an operation of natural selection on unbiased chance variations. There is evidence in the phylogeny of plants which has convinced some botanists that this is in fact the case.<sup>1</sup>

Another line of argument in support of my view is based on the recapitulation of the ancestry of a species in the course of its embryonic development. For this we must realise first of all that the variation of individuals on which natural selection operates are variations of their ontogenesis. If the variations of ontogenesis are biased in the direction of higher levels of life, then they will tend to extend the ontogenic

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process towards these higher levels. So that when such variants are hereditarily established, their ontogenesis will permanently include that of their pre-variant ancestor. This would account directly for the close resemblance found between the early stages of all embryos and also explain a tendency towards the recapitulation of the phylogenetic ancestry in the embryogenesis of the descendant.

This conception is clearly based on my personal appraisal of what is nobler and more highly significant in this world. When I evoke the spectacle of a universe which for billions of years had existed unseen, unheard, unfelt and altogether meaningless, except to its Creator, awakening here and there in tiny clusters of matter to desire, feeling and intelligence - these clusters being eventually even made to participate in the Creator's understanding of the universe and to feel obliged to justify their actions before him, I bear testimony to the very status of man which I myself must claim in order to warrant this appraisal of the universe by myself.

This kind of equilibration by which an embryo achieves its normal shape, or by which a mutilated organism regenerates an amputated limb, occurs always under the control of a guiding centre. Indeed, the field of a morphogenic organiser seems to be akin to the control exercised by the nervous system. And again, the precise interplay of the several organs functioning within the body of the higher animals is controlled by nervous centres. Morphogenesis and bodily functions do not merely happen, but they are being done. We may recognise in them the innate capacity of an organism for doing something. This capacity operates in the manner of an art and my knowledge of living action is therefore structurally akin to my appraisal of an art. This knowledge is two-storied, for it is not merely the knowing of a thing, but the knowing of

a doing and hence it is necessarily critical.

Though the critical functions of the observer are yet very meagre at this level, they are already clearly recognisable. Embryonic regulation achieves the same normal shape by starting from different mutilated germs. We may regard these alternative re-equilibrations as representing a group of rational actions on a rudimentary level and even acknowledge in these variations a measure of resourcefulness on the part of the organism. On the other hand, we shall regard as morbid any variations of the morphogenetic process which transform an apparently normal embryo into a malformed offspring. Both kinds of appraisals imply that the normal shape of the fully developed animal is known and identifiable and both use this shape as their ultimate standard of perfection.

Consider now the possibility of an hereditary modification of the germ plasm which results in the formation of a new true breeding strain. It is clear that while two such strains can be compared from many points of view and graded according to them, they cannot be compared in respect to trueness to type. Individuals belonging to either of them are both normal and abnormal according to different standards which can be compared only in terms of other standards than those which either of them represents. Mutations are therefore logically comparable to variations in the purpose pursued by a skilful performance or to an acquired taste which modify the sensual modality of connoisseurship.

We encounter a similar situation at a higher and greatly enriched level if we now turn to an appetitive function like feeding. Since we recognise as 'food' only materials which we believe to be nutritive and not deleterious to the animal it falls to us to this extent to determine what the purpose of feeding ought to be. This is often far from obvious. When a sheep eats the wool off the back of another sheep, or cattle eat bones, the uninstructed may object to this as an aberration,

of taste but physiologists approve of it as a compensation for certain mineral deficiencies in the animal's diet. Yet not everything that animals eat is nutritive or wholesome. It is easy to poison animals by arsenic or strychnine. It is possible to deceive them as the angler does when making fishes bite at his fly. Rats will drink saccharine solution which has no nutritive value and captive apes eat their faeces which seems to be quite useless as food.

The situation may be broadly characterised as follows: There is a wide range of choices which animals make in selecting their diet from variable supply of materials by which they seem to achieve a complex and accurate nutritive optimum under the given conditions. If this optimum, assessed by modern nutritional physiology, is regarded as the animal's purpose in feeding, his actions exhibit a high degree of rationality.

Wherever rationality is achieved there is a possibility of failure. Feeding may be wrong, and our criticism in such cases is more substantial than that which we have expressed in respect to morphological malformation, for we know that the animal is satisfying a desire. The dog-lover is painfully conscious of his dog's craving when it is showing signs of hunger. The rat's enjoyment of a sweet taste is the only reason that can be stated for its feeding on a solution of saccharine; if we refused to refer to sweetness we would reject an obviously true explanation and be left with none. And where there is conscious desire the performance which satisfies the desire has the character of an action. The rationality of such action is ascribed to the desiring and acting person and any failure of his action may then be regarded under new headings. False feeding may be classed with embryonic malformation as a diseased process. A maniac devouring paper or sand is suffering from a disease. But to the extent to which action is prompted by

desire we shall acknowledge also the possibility of a normal preference for merely subjective satisfaction and to the extent to which action is intelligent we shall recognise further that error may be a possible reason for failure. Moreover, animals can adapt themselves to a diet forced upon them. Pavlov has found (1898) that if a dog is continued on a diet of bread its pancreatic juice becomes increasingly effective in digesting starch. This acquired taste for bread weakens its capacity for digesting meat and makes its originally wholesome food indigestible to it: Such existential changes must be excluded in defining the rationality of the feeding process.

We may illustrate the expansion of the critical framework required for the observation of conscious forms of life also by reflecting on the observation of perception. We see the size of an object approaching the eye as constant so long as a certain relationship prevails between the effort of accommodation and the size of the retinal image. More precisely, we are jointly aware of the retinal image and of the adaptive effort as well as of certain relations of the two when both are undergoing a change, in terms of a constant size seen at variable distances. The observer of this process of perception will regard it as a rational performance if he endorses the affirmations implied in it, which is that the object has remained of constant size. But it may happen that the observer changes, unknown to the observed subject, the size of the object, a white sphere, for example by inflating it. It may then happen (Cantril) that the subject increases his accommodation as if the object were approaching and becomes aware of the increased effort coupled with an increased retinal image by seeing the swelling object approaching at constant size. In this case the seeing of a constant size is regarded as an error due to a mistaken perception. If the effort required for a certain measure of accommodation is increased by atropin poisoning

an approaching object will be seen shrinking to a tiny size and the reduction of its size will make it appear farther off. Owing to the conscious character of perception we can know this anomalous form of it and regard it as a subjective experience of the perceiving person.

By the last two illustrations we have ascended to the level where our knowledge of a living being becomes an encounter with a living agent. At the appetitive and perceptive level the animal is the centre of conscious efforts directed towards possession of things and knowledge of things. We are aware of the animal's active person in terms of the same kind of particulars in terms of which the animal integrates its own action. An understanding of the hungry animal choosing its food or of an animal on the alert listening and watching, is an act of personal knowledge similar in its structure to the animal's personal act which it appraises. Like all personal knowledge of a molar feature this act involves a critique of this feature. It affirms that its particulars are its rational subsidiaries and acknowledges a wide field of such possible rational relations, centering on the achievement of the molar intention. Within this framework every observation has a critical significance, being seen as contributing to the success or causing the failure of the molar intention. This intention itself remains unquestioned within this framework. But the centre of this particular molar feature, namely the craving and perceiving animal, is conscious and we can share its consciousness to some extent. This allows us not only to understand its achievements better than those of a machine of unknown purpose, but it also enables us to assess certain failures as errors or as merely subjective satisfactions.

Behaviourists teach that in observing an animal we must refrain above all from trying to imagine what we would do if placed in the animal's position. I suggest on the contrary that

nothing could be known about an animal that would be of the slightest interest to physiology and still less to psychology except by following the opposite maxim of identifying ourselves with a centre of action in the animal and criticising its performance by standards set up for it by ourselves.