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The Structure of Tacit Knowing

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(As delivered on February 17, 1964 at Duke University)

In my previous lecture I distinguished between the explicit content of a theory and its anticipatory powers. I ascribed this surplus of meaning to the image of the theory. For modern physics this is embodied in the beauty of its mathematical form. I said that the harmonies of such an image and of such mathematical formulations establish a presumption, that the theory has a bearing on reality and that by virtue of this bearing it might anticipate future discoveries. I spoke of the heuristic powers of the mind, which enable us to discover such harmonies, by grasping the coherence of clues which point to it; of clues which eventually may later be seen to form part of new discoveries. One could describe this process as the structuring of reality.

My present lecture will analyse the structuring of reality. It is effortlessly done by our eyes and ears every time we see or listen to something. But its exercise may also be most arduous and indeed amount to scientific achievements like those of Copernicus. The effortless feat of our eyes and ears is an act of perception, while the discoveries of Copernicus were the work of the speculative imagination. Both have it in common that they are not explicit processes: not carried out on paper. They are informal, tacit operations. We shall see that, beside perception and the imagination, the forming of conceptions can also involve a tacit integration of clues amounting to a structuring of reality. We may include among the structuring powers also the developing and exercise of a skill. All practical knowledge relies ultimately on skil-

ful operations and in science we find everywhere observation combined with skilful testing. It will also simplify my argument, if it be understood that when I speak of comprehension, I shall include, beside the comprehensive seeing of things, the handling of them and the skilful co-ordination of our muscles. Intellectual and practical comprehension are always combined within our own body.

For an experimental knowledge of the tacit operations establishing coherence in nature, we must rely on the study of perception by Gestalt psychology. It has more recently been expanded further by transactional psychology. These studies have revealed the complex procedure involved in seeing a simple solid object in front of us. Suppose I look at my right hand. I recognise its area by its closed contours. But if that were all, my hand, when moved about, would keep changing its colour, its shape and its size. The experience of my hand as a solid object, having definite properties, would never arise. I see it as such, by integration of a host of rapidly changing clues, both in the field of vision and inside my eyes and some still deeper in my body. My powers of recognising coherence makes me see these thousand changing clues jointly, as one single unchanging object moving about at different distances, viewed from different angles, under variable illuminations. A successful integration of thousand variable particulars into a single constant sight, makes us recognise that we have a real object before us.

We can get an important hint of the way this integration takes place, by looking at an object, for example, a finger of our own, through a pinhole in a sheet of paper. If I do this and then move my finger back and forth, I see it swelling as it approaches my eye.

Psychologists have called this effect a "de-realisation". The moving object has lost in it some of its invariance, for it lacks confirmation by the elements that normally contributed to its image from the periphery of the visual field and from the other eye. The coherence established by our perception has been impoverished and with it the object has lost some of its apparent reality.

Reflecting on these examples of seeing an object, we learn two things. First, that our tacit powers can integrate a much larger number of variables at a far greater speed than any explicit procedure, registering each of these variables in turn, could possibly carry out. The importance of this for the pursuit of scientific discovery seems obvious, but I shall pass by it now. The second thing we learn is the fact that most of the clues we integrate so successfully to seeing an object are not known to us in themselves. Many of them cannot be sensed at all. The contractions of our eye muscles, for example, can never be experienced as such, we are aware of them only in the way they make us see the object that we are perceiving. Other clues, like those we cut out by a pin hole, we do sense, but only from the corner of our eye. We do not attend to these either, but rely on our awareness of them for attending to the coherent entity to which they contribute.

We can recognise here two kinds of awareness that will prove fundamental to the tacit apprehension of coherence. Gestalt psychology has always insisted that when we comprehend a whole, we see its parts differently than we would see them in isolation; that seen as parts they have a functional appearance, which they lack in isolation. We may generalise this by saying that the tacit knowing of a coherent entity begins, when we convert bits of experience—

which may be either subliminal or sensible--into clues to this coherent entity. This process includes the co-ordination of muscular actions which will both serve and shape our apprehension of the entity. The understanding of its coherence is completed, when the clues and the working of our muscles are embodied in the appearance of the entity to apprehension of which they were directed. Such is the functional structure of tacit knowing.

Let me emphasize the phenomenal changes marking this functional integration. We have noticed it when I described the seeing of my hand as an invariant real object integrated from thousands of swiftly changing clues. The way I come to see my hand, the distance at which I see it, the shape I see it having, its colour and texture, the speed and direction of its motion, all its sensory qualities, are determined by clues--whether manifest or deeply hidden and subliminal--which are integrated into its appearance. All these clues are now seen in the qualities of the object to which they have been integrated. I shall call this transformation of qualities, the phenomenal aspect of tacit knowing.

But is it a fact that tacit knowing altogether surpasses explicit operations in achieving perception? Let us see. Take one element of visual perception: our capacity for seeing things stereoscopically, as objects distributed in depth, each surrounded by empty space. The way we usually do this is a little complicated, but we can simplify our enquiry by starting with a stereoscopic photograph. A careful scrutiny of its two pictures will show, that each object is depicted in them by a pair of slightly different images, taken from slightly different angles. The difference will be smaller for some objects, showing that they are further away.

Some machine could conceivably work out both the position of each object in space and the round shape of the several objects. They might supply us, for example, with the spacial coordinates of all the surfaces of the objects; or with a set of cross sections of the scene, spaced inch by inch. But I can hardly think of any purpose this tremendously complicated information would serve, and it certainly could not replace the knowledge we can obtain at one glance by looking simultaneously at one image with each eye.

I have compared before a list giving the geographical position of all the towns in England, with a map of England showing these towns as disposed over the surface of the country. A computer could no doubt be devised to derive any particular itinerary from a list of positions, but the map would still be far more useful in guiding our imagination to ask new questions and form new projects by looking at the map.

The unrivalled interpretative powers of tacit comprehension lie in the appearance of the coherence which they establish. This may be a sensory appearance, as in visual perception, or an imaginative appearance, as in the map of a country. Our understanding of perceived experience lies in the sensory qualities which indicate the coherence of a multitude of sensory clues and convey their meaning to us. Since no explicit operation can produce such transformation of qualities, it would seem that in this case tacit integration is superior not only in practice, but in principle, to any conceivable explicit integration of the information contained in an aggregate of sensory clues. <u>Seeing is not guided by these clues as noted in themselves, but by the quality of their joint appearance</u>.

Experiences with inverting spectacles supply even more telling evidence to show that an explicit solution of a perceptual problem is ineffectual and indeed pointless. If you put on spectacles which make you see things the wrong way round--for example inverted between left and right--you feel completely lost. You are unable to use your hands or to walk about the room. Yet you have a perfect solution to your problem in explicit terms. What you see on your right is really on your left and vice versa. This is all you have to know, but this knowledge is useless. It takes too long to apply it and hence you continue to react to what you falsely see, rather than to what you would know, if you followed the prescription for transposing the things you see into their correct location. On the other hand, what explicit instruction fails to convey, is achieved by the tacit action of our senses. If you persist in your effort to find your way, while wearing inverting spectacles, you will eventually see things rightly again.

Stratton who first discovered this fact in 1896 could find his way about by inverting spectacles after wearing them for 8 days. Other observers confirmed Stratton's experience. The result of such training is so striking that it was long believed to consist in the reversal of the visual image to right way round. But this is not so. The experiments of Snyder and Pronko (1952) and of Ivo Kohler and his pupils in Innsbruck have shown that this interpretation was wrong. The sight of things is reversed only in the sense that they are once more seen right, that is, seen in such a way that the subject can find his way about by following what he sees. He finds his way, because the new way of seeing things once more coordinates his vision with the feelings of his muscular action. In

a sense, things visually observed the wrong way round are felt then to be the right way round; a subject wearing right-left inverting glasses will say that "depending on whether I attend more to my hand or to the rest of the visual field, I would ascribe to it the quality of rightness or leftness." Actually, visual and proprioceptive qualities are fused to a novel mode of perception, in terms of which the subject achieves a correct understanding of the inverted sights. Summing up the results of the Innsbruck School, Kottenhoff, a pupil of Ivo Kohler writes (1961) that at this stage of the experiment "the question whether something is to the right or to the left was felt to be rather annoying." Snyder and Pronko observed the same tendency in the following way. The subject, wearing upside-down inverting spectacles, "was observing the scene from a tall building. Suddenly someone asked, 'Well, how do things look to you? Are they upside down?' The subject replied, 'I wish you hadn't asked me. Now, when I recall how they did look before I put on these lenses, I must answer that they look upside down now. But until the moment that you asked me I was absolutely unaware of it and hadn't given a thought to the question whether things were right-side-up or upside-down.'"

Thus it appears that

1) an explicit prescription for interpreting experience is of little use for finding one's way by inverted vision;

2) an effective understanding of the situation is achieved tacitly by acquiring a novel way of seeing things. Clues of vision and motion are fused thereby into a new sensory quality, which presents a correct conception of the situation;

3) attempts at describing this quality in words denoting the

normal qualities of sight and motion have misled earlier writers and half a century passed before they discovered what they were actually seeing. The reason for this blindness was that the novel sensory qualities of right seeing through inverting spectacles can be described only by terms which in ordinary parlance would be self contradictory.

In my last lecture I criticised the view that science is and ought to be an explicit functional relation between observed data and showed that the appearance of a theory in which lies its intellectual beauty, conveys a surplus meaning which, by bearing on reality, possesses anticipatory powers. We can see now that right perception has a distinctive sensory quality which bears on reality. Wee see that it thereby keeps the joint meaning of perceptual clues in evidence, and that this quality and this meaning can be lost if an attempt is made to spell out the relation of these clues in terms of an explicit functional relation. These facts strongly confirm my contention that only tacit knowing can solve a perceptual problem. It also indicates that such a solution will constitute a conceptual innovation.

Indeed, from the fact that questions put in a language using the normal conceptions of 'above' and 'below' or 'right' and 'left' cause confusion in the minds of subjects who have learned the right way of seeing with inverted spectacles, we can conclude that the new kind of seeing is accompanied by a corresponding conceptual change, which extinguishes the usual meaning of the words "above" and "below" and "right" and "left". Since, as I hope to show in my next lecture, the formation of concepts is a prominent function of tacit knowing, a conceptual <u>reform</u> accompanying perceptual innovations,

must also be predominantly tacit.

By passing from perceptual to conceptual change, I can return to the subject of scientific discovery, and the nearest example to which I can turn I shall find in the discovery of relativity. The process in which relativity originated, was in fact analogous to the way one learns to see rightly with inverting spectacles. Einstein has told the story, that from the age of sixteen he was obsessed by a speculation which eventually led to his discovery. It had long been known that experiments with falling bodies give the same result on board of a ship in motion as it does on solid ground. But Einstein, as a boy, asked about the light which a lamp would emit on board a moving ship. Supposing the ship moves fast enough, will it overtake the beams of its own light, as an aeroplane overtakes its own sound when reaching the supersonic barrier? Einstein thought that this was inconceivable, and he re-formed the conceptions of space and time in a way which would make it impossible for the ship to be said to overtake, however slightly, its own light rays. The result was, that questions about a definite span of time or space became meaningless and confusing--just as questions of right and left became meaningless and confusing for a subject wearing inverting spectacles, who had righted his vision. I have been told that in the psychological laboratory at Innsbruck they substitute for the German designation of right and left, the English words "right" and "left" to designate the new kind of alternatives seen by re-verted vision. This is exactly as in relativistic language, the words "length" and "duration" are revised by linking them always to a particular observer. Such conceptual changes are primarily tacit, even though they may be supported, as in the case of

relativity, by formal expressions corresponding to them.

I think it is no accident that it is the most comprehensive innovation in the history of science that appears most similar to the way we acquire the capacity for seeing things rightly. For only such a comprehensive problem, as that of relativity, can require a reorganisation of such basic conceptions as we undertake in learning to see rightly through inverting spectacles. This righting of our vision involves also a conceptual innovation as sweeping and as paradoxical as that achieved by Einstein in formulating relativity.

I have shown that in the process of perception, in the forming of new conceptions and in the exercise of the imagination, we can establish a valid coherence of particulars which lends their joint appearance a new convincing quality. The way tacit knowing achieves this result will become much clearer if we now turn our attention to the fact that by tacit integration we can get to know considerably more than we can tell.

I have implied this fact already in pointing out that we do not know in themselves the perceptual clues by which we discern an object. We could analyse in this sense the conceptual reforms involved in learning to see through inverting spectacles and also the discovery of relativity. But I want to bring in some new material in which this feature of tacit knowing is more clearly identifiable.

The classical case of knowing more than you can tell is met in the knowing of a skill. I know how to ride a bicycle or how to swim, but this does not mean that I can tell by what principle I keep my balance on a bicycle or keep afloat when swimming. I may not have the slightest idea of this or even an entirely wrong idea of it, and yet go on cycling or swimming merrily. And suppose I

cannot ride a bicycle, it would not help me if I were told that in order to compensate for a given angle of imbalance α, I must take a curve on the side of the imbalance, of which the radius r should be proportionate to the square of the velocity v over the imbalance α ($r \propto v^2/\alpha$). Such knowledge, though true, is ineffectual unless it is possessed tacitly.

We know a person's face and can recognise him among a thousand, indeed among a million. Yet we usually cannot tell how we recognise a face we know. There are many other instances of the recognition of a characteristic appearance--some commonplace, others more technical--which have the same structure as the identification of a person. At the universities great efforts are spent in practical classes to teach students to identify cases of diseases and specimens of rocks, plants and animals. All descriptive sciences study such physiognomies which cannot be fully described in words, nor even by pictures. All this practical teaching must rely on the intelligent pupil's capacity to recognise the relevant particulars of a physiognomy and their characteristic relationship in the physiognomy.

But can it not be argued that the possibility of teaching skills and the recognition of characteristic appearances, proves that we can tell our knowledge of them? No, what the pupil must discover for himself by trial and error is--even though he be guided by our advice and example--something we could not tell him.

This will become clearer from some fairly recent work in psychology. This has developed a method for studying the elementary act on which all tacit knowing is based. The wider public has heard of these experiments as exposing the machinery of hidden persuasion

More important seems the fact that they isolate for experimental investigation the faculty by which we apprehend the relation between two events, both of which we know, but only one of which we can tell.

Following the example set by Lazarus and McCleary in 1949, psychologists call the exercise of this faculty a process of "subception". These authors presented a person with a large number of nonsense syllables, and after showing certain of the syllables, they administered an electric shock to the subject. Presently the person showed symptoms of anticipating the shock at the sight of "shock syllables"; yet, on questioning, he could not identify them. He had come to know when to expect a shock, but he could not tell what made him expect it. He had acquired a knowledge similar to that which we have when we know a person by signs which we cannot tell.

Another variant of this phenomenon was demonstrated by Erickson and Kuethe in 1956. They exposed a person to shock whenever he happened to utter associations to certain 'shock words'. Presently, the person learned to forestall the shock by avoiding the utterance of such associations, but, on questioning, it appeared that he did not know he was doing this. Here the subject invented a practical operation, but could not tell how he worked it. This kind of subception has the structure of a skill, for a skill combines elementary muscular acts which are not identifiable, according to relations that we cannot define.

These experiments show more clearly than the recognition of physiognomies can do, that we can know more than we can tell. For the procedure wards off the suspicion of self-contradiction, which

arises when anyone speaks of things he knows and cannot tell. It is avoided by the division of roles between the subject and the observer. The experimenter observes that another person has a certain knowledge that he cannot tell, and so no one speaks here of a knowledge that he himself has and cannot tell.

We can sum up so far as follows. In two experiments, subception was induced by electric shock. In the first series, the subject was shocked after being shown certain nonsense syllables, and he learnt to expect this to happen. In the second series he learnt to suppress the uttering of certain associations, which would evoke the shock. In both cases the knowledge of the shock-producing particulars remained tacit. The subject could not identify the particulars, yet he relied on his awareness of them for anticipating the electric shock.

Such is the basic structure of tacit knowing. It always involves two things bound together by being known in two different ways. We may call them the two terms of tacit knowing. In the subception experiments the shock-syllables and the shock-associations formed the first term and the electric shock which followed them was the second term. After the subject had learnt to connect these two terms, the sight of the shock syllables evoked the expectation of a shock and the utterance of shock associations was suppressed in order to avoid shock.

Why did this connection remain tacit? It would seem that this was due to the fact that the subject was riveting his attention on the electric shock. He was relying on his awareness of the shock producing particulars only in their bearing on the electric shock. He came to rely on his awareness of these particulars for the pur-

pose of attending to the electric shock.

I have spoken before of the functional way the clues to a comprehensive entity are related to this entity. This relation is isolated here in its elementary form. Within a tacit knowledge combining two terms, we know the electric shock, forming the second term, by attending to it, and hence we know it indentifiably. We know the shock-producing particulars only by relying on our awareness of them for attending to something else, namely the electric shock, and hence our knowledge of them remains tacit. We come to know these particulars as clues to the shock without becoming able to identify them as such. In the comprehensive entity formed by the two terms of tacit knowing, we know the first term only by relying on our awareness of it for attending to the second, viewed as the center of the comprehensive entity.

In his book on Freedom of the Will, Austin Farrar has spoken of disattending from certain things for attending to others. I shall adopt a similar usage by saying that in an act of tacit knowing we attend from something for attending to something else; namely, from the first term to the second term of the tacit relation, as the center of this relation. In many ways the first term of this relation will prove to be nearer to us, the second further away from us. Using the language of anatomy, we may call the first term proximal, and the second term distal. It is the proximal term, then, of which we have a knowledge that we may not be able to tell.

In cases when there are a number of proximal terms, the distal term may be the comprehensive entity having no concrete center, to which we are attending from its parts. In the case of a human physiognomy, we rely on our awareness of its features for attending

to the characteristic appearance of a face. We are attending from the features to the face, and thus may be unable to specify the features. We are relying likewise on our awareness of a combination of muscular acts for attending to the performance of a skill. We are attending from these elementary movements to the achievement of their joint purpose, and hence are usually unable to specify these elementary acts or the principle by which we are combining them.

In my first analysis of tacit knowing by the example of looking at my finger, I found the functional coherence of its structure vividly reflected in the firm and constant appearance of the perceived object. This phenomenal aspect of coherence was manifested even more strikingly by the perceptual innovation of learning to see rightly through inverting spectacles. The appearance of the experimental setting--composed of the nonsense syllables and the electric shocks--undergoes a more subtle change, when we learn to anticipate a shock, our expectation of it which at first had been vague and uncertain, becomes sharply fluctuating; it suddenly rises at certain moments and subsides between them. So we may say that, even though we do not learn to recognise the shock syllables as distinct from other syllables, we do become aware of a shock-syllable in terms of the apprehension it evokes in us. In other words, we are aware of seeing these syllables in terms of that on which we are focussing our attention, which is the probability of an electric shock. Thus also, in the case of a physiognomy, we are aware of its features in terms of the physiognomy we are looking at and in the exercise of a skill, we are aware of its several muscular moves in terms of the performance to which we are attending.

We can see here how intangible qualities may appear as tokens of deep unspecifiable structures. How we can read a character in a face or a posture and meet in a person's presence all that we know of his past. This will be seen to supply the mechanism by which we know another mind. We see re-appearing here also for a moment the original problem of our enquiry. We recognise that the logical position of a theoretical image in science is that of a comprehensive entity to which we are attending from its particulars. This is how in such an image we are aware of a coherence that is a token of reality.

There is a significance in the relation between the two terms of tacit knowing which combines its functional and phenomenal aspects. When the sight of certain syllables makes us expect an electric shock, we may say that they signify the approach of a shock. This is their meaning to us. Therefore, when shock syllables arouse an apprehension in us, without our being able to identify the syllables which arouse it, we know these syllables only in terms of their meaning. It is their meaning to which our attention is directed; it is in terms of their meaning that they enter into the appearance of that to which we are attending from them.

We could say, in this sense, that a characteristic physiognomy is the meaning of its features; which is, in fact, what we do say when a physiognomy expresses a particular mood. To identify a physiognomy would then amount to relying on our awareness of its features for attending to their joint meaning. This may sound far-fetched, because the meaning of the features is observed at the same spot where the features are situated, and hence it is difficult to

separate mentally the features from their meaning. Yet, the fact remains that the two are distinct, since we may know a physiognomy without being able to specify its particulars.

To see more clearly the separation of a meaning from that which has this meaning, we may watch the use of a probe to explore a cavern, or the way a blind man feels his way by tapping around with a stick. Anyone using a probe for the first time will feel its impact against his fingers and palm. But as we learn to use a probe, or to use a stick for feeling our way, our awareness of its impact on our hand is transformed into a sense of its point touching the object we are exploring. Thus our interpretative effort transposes our meaningless feelings into meaningful ones, and places these at some distance from the original feelings. We become aware of the feelings in our hand in terms of their meaning located at the far end of the probe or stick, for it is to this end that we are attending. This happens also when we learn to use a tool. We attend to the meaning of its impact on our hands in terms of its effects on the things to which we are applying it and thus make these effects increasingly meaningful. We may recognise in this the semantic powers of tacit knowing.

The way the skilful use of a tool or probe makes us feel the meaning of their impact on our hand at the far end of these instruments, reflects a general tendency for meaning to be displaced away from us. This is in fact my justification for using the terms 'proximal' and 'distal' to describe the first and the second term of tacit knowing.

Let me return, with this in mind, to the mechanism of visual perception. I have mentioned the well known fact that the way we

see an object is mainly determined by our awareness of certain events inside our body, which we cannot feel in themselves. We are aware of these processes inside our body in terms of position, size, shape and motion of an object, to which we are attending. In other words, we are attending from these internal processes to the qualities of things outside. These qualities are what those internal processes mean to us. The transposition of bodily experiences into the perception of things outside, may appear then as an instance of the transposition of meaning at a distance which we found present in all tacit knowing, and, most strikingly, in the use of tools and probes.

It may be thought that the feelings transposed in perception differ from those transposed in the use of tools or probes, by being hardly noticeable before their transposition. An answer--or at least part of an answer--is to be found in experiments extending subception to subliminal stimuli. Hefferline and collaborators have observed (1959) that when spontaneous muscular twitches, unfelt by the subject--but observeable by a million-fold amplification of their action currents--were followed by brief cessation of an unpleasant noise, the subject responded by increasing the frequency of the twitches and thus silencing the noise for a longer time. Experiments carried out during the past decade in Soviet Russia have shown this phenomenon in a different manner. (Razran 1961) When an internal stimulus, which the subject cannot notice in itself--such as the inflating of a rubber ball in the intestinal canal--is repeatedly followed by a reward or punishment, the internal stimulus will come to arouse an anticipation of these events. We have here a process similar to that which I have postulated for explaining

that in the act of perception we become aware of subliminal events inside our body in the way we see things outside.

This view of perception as a transposition of feelings--like that observed in the use of probes and in the process of subception--is borne out by the fact that the capacity to see external objects is acquired, like the use of probes and the feats of subception, by an effort of learning which can be laborious.

Modern philosophers, like Ryle, have argued that perception does not involve projection, since we are not previously aware of the internal processes which we are supposed to have projected into the qualities of things perceived. But we now have established that projection of this very kind is present in various instances of tacit knowing. Moreover, the fact that we do not originally sense the internal processes in themselves, now appears irrelevant.

I would venture, therefore, to extend the scope of tacit knowing to include the neural traces in the cortex of the nervous system. This would place events going on inside our brain on the same footing as the subliminal twitches operated by Hefferline's subjects. The relation of mind and body becomes then an instance of the relation between the two terms of tacit knowing. Such a hypothesis does not explain how perceived sights, or any other states of consciousness, arise in conjunction with neural processes. It merely applies the principle that wherever some process in our body gives rise to consciousness in us, our tacit knowing of the process will make sense of it in terms of an experience to which we are attending.

This conception of the way the body participates in the act of perception, can be generalised to include the bodily roots of all

knowledge and thought. It throws light then on the peculiar knowledge we have of our body by living in it.

Our body is the only collection of things which we know almost exclusively by relying on our awareness of them for attending to something else. Parts of our body serve as tools for observing objects outside us and for manipulating these for purposes of our own. Every time we make sense of the world we rely on our tacit knowledge of impacts that the world makes on our body and of the response of our body to these impacts. Such is the exceptional position of our body in the universe.

I have described how we learn to feel the end of a tool or a probe hitting things outside. We may regard this as the transformation of the tool or probe into a sentient extension of our body. But our awareness of our body for attending to things outside it suggests a wider generalisation of the feeling we have of our body. Whenever we are using certain things for attending from them to other things (in the way we usually use our own body) these things change their appearance. They appear to us now in terms of the entities to which we are attending from them, in the same way as we feel our own body in terms of things outside to which we are attending from our body. In this sense we can say that when we make some things function as the proximal term of tacit knowing, we incorporate these things in our body--or extend our body to include them.

Let me show you at a glance the world-wide consequences of this conclusion. We make a thing function as the proximal term of a comprehensive entity whenever we see it as part of a whole. We have analysed many instances of this kind: the seeing of a solid body, the discovery of relativity, the identification of physiognomies,

the practice of skills. We could apply our present conclusions to all these, but I want to throw a quick glance over wider fields. Biology studies the shapes of living things and the way they grow into these shapes from germ cells; it describes the organs of living things and explains the way they function; it explores the motor and sensory functions of animals and their intelligent performances. All these are comprehensive entities. Morphology, physiology, animal psychology--they all deal with comprehensive entities. The only way to know them is to comprehend the coherence of their parts. The structure of tacit knowing requires that we make these parts function as proximal terms, in the way we make our body function for handling things outside. It requires that, in this sense, we interiorise these things in order to attend from them to the comprehensive entity which they form. We must dwell in them, and not observe them in themselves, if we are to be aware of their bearing on the entities to which they belong. Only thus can we understand the way these comprehensive entities rely on their parts for performing their functions.

This adds another important feature to the structure of tacit knowing. It tells us what it is a knowledge of. We may call this its ontological aspect. I look forward to showing you as I go on in these lectures that tacit knowing is in fact the sovereign instrument for establishing the existence of comprehensive entities and understanding their structure. At the same time, looking back on the process of scientific discovery, we can see it confirmed here that in tacit knowing we have found a means of establishing coherence that clearly bears on reality.

Let us realise now the peculiar position at which we have arrived. We have seen the way tacit knowing establishes coherence by the powers of perception, conceptualisation, speculative imagination and skilful effort. Compare this way of getting to know things with the acquisition of knowledge by a process of explicit inference. In both cases there are two terms involved. The two terms of explicit reasoning are its premises and its conclusions, those of tacit knowing are its proximal and its distal terms. Explicit reasoning subjects explicit premises to formal operations and thus reaches explicit conclusions. Tacit knowing leads from its proximal term to its distal term by relying on the first for attending to the second; it brings to bear the proximal on the distal, and establishes the latter as the meaning of the former. This is not done by a formal operation but by a process of integration striving for understanding. Nor is its result a conclusion that can be detached from its logical antecedents: when proximal things come to be understood as particulars of an entity to which they contribute, we remain aware of them in terms of this entity.

Explicit inference is the ideal of critical reason, for it is open to indefinitely repeated re-examination, bit by bit. You can scrutinise each of the premises in turn, and likewise the several operations by which you derived your result from them. A return to the antecedents of an act of comprehension is much more difficult and uncertain. It involves an analysis of tacitly known particulars, which--as we have seen--may not be identifiable, and also the revising of an act of integration, guided by undefinable harmonies. An explicit inference can therefore be refuted by bringing up new evidence against it, while a tacit interpretation of clues, may not

be shaken by facts that conflict with it. We may actually know a perception to be illusory, and yet find that our eyes continue to present it to us.

Science has set us an ideal of critical exactitude which would eliminate such hazards and this ideal may well seem to represent our intellectual duty. For the immense superiority of human intelligence over that of the animal is due entirely to our capacity for explicit thought. Jean Piaget confirms the ideal of explicit inferences in his Psychologie de l'Intelligence and other writings, when he demonstrates the growth of intelligence in maturing children in terms of the replacement of senso-motoric knowing by formal operations of the mind. He calls this a development from irreversible mental acts to reversible modes of inference. So taken is the great master by this growing mechanical efficiency of the mind, that he fails to deal with the fact that the irreversible acts of the mind include all its creative functions.

Most writers on scientific knowledge express a similar preference for explicit thought by refusing to deal with the tacit process of discovery, which they assign to psychology or sociology. But I cannot see how a theory of knowledge can ignore the main process by which new knowledge is obtained. It is to perform Hamlet without the prince. For scientific opinion awards its highest prize to feats of originality, that a restriction to explicit processes would exclude from the study of scientific knowledge.

I cannot deal with this conflict here. It is but a symptom of the universal tension between a triumphant lucidity attacking theoretically defenceless intangible realities. All my writings are but an attempt to resolve this fateful tension, and the issue still

remains in the balance.

But we have some results to carry forward that will bear on this problem. I shall survey them under five headings.

1) Functional structure of tacit knowing. We possess an experimentally verifiable capacity for attending from one thing to another. The proximal term in this relation might be known only tacitly, that is, by relying on our awareness of it for attending to the distal term, or else to an entity comprehending both terms. A proximal term may be subliminal; in any case, not identifiable. This is how we can know more than we can tell.

2) Semantic and phenomenal aspects. Tacit knowing lends a meaning to the proximal term of which we are aware in the appearance of that which it means, be this the distal term or the comprehensive entity formed or recognised by the act of tacit knowing. There are important instances when a large number of particulars function proximally as clues to their joint meaning. This coherent whole is then their distal term; its harmonious appearance is token of its reality. We have seen perceptual innovations, conceptual reforms and scientific discoveries made by such a process. This seems to be the general structure of creative mental acts.

3) Indwelling. As we live in our body, we know it principally by attending from it to things outside. Hence we may be said to use proximal terms when attending away from them, as we use our body; and hence also the meaning of proximals tends to be displaced away from us. To understand a complex entity, like a living being, is to interiorise its particulars with a bearing on the comprehensive functions of the living being.

4) Intuition. Since the coherence which equals a discovery is

achieved by a tacit integration, many of the clues on our awareness on which we rely for making that discovery may not be identifiable. Tacit knowing will tend to reach conclusions in ignorance of the steps employed. This is the process commonly known as intuition. We can see now that this faculty is experimentally demonstrable. It is not particularly mysterious and certainly not infallible. The traditional association of intuition with infallibility is profoundly misleading.

5) Personal knowledge. The personal acts by which alone tacit knowledge can be acquired can all be derived from the way tacit knowledge is established by indwelling. Therefore, since all our knowledge, being rooted in our body, depends on the contributions of tacit coefficients, we shall have to abandon the conception of strict scientific detachment and seek to establish instead a truer ideal of knowledge, which would accept indwelling as the universal principle of knowing.