SCIENCE AS PERSONAL ART

Michael Polanyi on the Role of Scientist's Personal Involvement in Scientific Knowledge

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Abstraksi

Sebagai pengetahuan yang mengandalkan data yang dapat dibuktikan dan prosedur ilmiah yang baku, pengetahuan ilmiah dianggap sebagai pengetahuan yang paling dapat dipercaya dan meyakinkan. Keilmiahan disamakan dengan bebas dari segala faktor subjek, karena keterlibatan subjek dianggap menodai kemurnian pengetahuan. Ilmuwan dalam pengertian yang demikian disamakan dengan mesin pencari kebenaran yang tidak memiliki kebebasan dan kreativitas. Pandangan ini, menurut Mikael Polanyi, tidak sesuai dengan kenyataan yang sebenarnya. Proses yang ditempuh oleh seorang ilmuwan dalam mengusahakan suatu penemuan, misalnya, tidak terlepas dari faktor-faktor personal yang tidak seluruhnya bisa dijelaskan dan ditetapkan secara baku. Berangkat dari pengalaman Michael Polanyi sebagai ahli dalam bidang fisika dan kimia, refleksinya mengenai bagaimana sesungguhnya ilmuwan bekerja menjadi lebih otentik dan aktual.

Key words: *science, knowledge, objectivity, tacit, reality, personal, skill, focal, participation, particular, insight, explanation, experiencence.*

Introduction

Our age is marked by a notably influential phenomenon of science prevailing in every domain. There is no area of our life which is not tempted to be scrutinised by scientific approach. Science has strengthened and is still strengthening its role in dealing with the enigma of the world from inanimate things to the mechanism of conscious beings. There is no doubt that in such an effort science is gaining more and more applause and support under the conviction that it gives more a true and more fair approach to reality in comparison with other explanations. Thanks to science we have now a better understanding of so many problems that hitherto remained in the dark.

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Moreover, we are offered many and varied opportunities for dealing with nature and organising our performance for a certain purpose.

Unfortunately, such a triumph comes not without certain lateral consequences. The claim that the scientific approach is the only true and valid explanation of reality leads to a conviction that other explanations which belong to the rest of our culture,[1] were altogether nonsense. Science is considered to be winning the competition by offering the most convincing and complete feature of the reality. It should not be so menacing if there were not a sharp opposition created between science and the rest of our culture. In reality, however, there is a gap between them, for science tends to discredit other expressions of our experience and our enterprise to grasp the meaning of reality seen as unscientific.

Why is it then that science is so successful in gaining support of the modern mind? It is generally held that the answer must be found on the objectivity claimed by science. The objectivity is the most decisive word in the vocabulary of science. The obsession of a scientist is to give a thoroughly detached description of reality so as to offer a true knowledge of his subject. There are of course some parallel movements sharing the same spirit claiming the detachment as the criteria of true knowledge. Materialistic–positivism, Behaviourism, and Nihilism are all on the same line. Their obsession is to remove any human element from their presentation of reality. For, in their point of view, such a trace offers nothing but a defect in acquiring a true knowledge.

In his disagreement to such a programm, Polanyi displays the role of personal participation in achieving and holding scientific knowledge. Knowledge is a skill requiring the involvement of the performer. Polanyi writes, "... all knowing is action—that is our urge to understand and control our experience which causes us to rely on some parts of it subsidiarily in order to attend to our main objective focally."[2] Such a structure of knowledge is equally valid for the scientific knowledge.

This article shows how Michael Polanyi deals with the problem of objectivity as the main preoccupation of modern science. Through his idea of a personal knowledge Michael Polanyi insists that scientific knowledge is and has to be an act of a person, that is of the scientist. This leads us to acknowledge the tacit component in scientific knowledge notwithstanding the scientists' claims of explicity and demonstrability,

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[1]M. Polanyi, *Knowing and Being*, University Press, Chicago Press 1969, p. 40.

[2]M. Polanyi , *Meaning*, The University of Chicago Press, Chicago 1975, p. 42.

etc. In this circumstance it will be clear that natural science and the science of humanity have no great difference. Science then does not contradict values as it tends to be mentioned by modern mind. Parallel to his notion about the presence of a rationality in nature, Polanyi sustains the power of intuition to acquire the rationality in nature. Such power is indispensable in the process of discovery. He delights in G. Polya's assertion that discovery, even in mathematics field, is an extremely delicate personal art that cannot be presented in a mathematical formula. He refers also to Poincaré who argues that a discovery is a spontaneous emergence. Polanyi underlines the power of our creative guesswork guided by the urge to make contact with a reality.

It should be kept in mind that such reaffirming the tacit base of knowledge forms Polanyi's far–reaching endeavour to find an alternative idea of scientific knowledge. When Polanyi speaks about the tacit knowledge his attention touches, undoubtedly, the scientific knowledge as his main target. In this article I will explore his idea of the nature of scientific knowledge; how he discerns the unaccountable element prevailing in science; that science requires indispensably the scientist's tacit construction of particulars elements in a joint meaning.

The Tacit Base of Knowledge

It is a general assumption in modern science that detached and objective knowledge is the most required characteristic of scientific approach. Knowledge, then, has to be wholly specifiable and explicit. This, according to Polanyi, is a fatal misconception of every kind of knowledge, for such an assumption does not recognise the hidden and tacit aspect on which the explicit knowledge founds its base. That is why that in his endeavour to approach the nature of knowledge he immediately refers to the very characteristic of knowledge. He writes: "I shall reconsider human knowledge by starting from the fact that we can know more that we can tell."[3] This fact, though not so easy to be explained, is obvious in the daily experience. We know for example the difference of a face, let us say the face of our friend, between hundreds even thousands of others, yet we are not able to show precisely every characteristic feature of that friend that tells the difference from another.

This does not mean that our respective knowledge is not based on the reality of the face. It is, but most of this knowledge cannot be put

[3] M. Polanyi, *The Tacit Dimension*, Anchor Books – Doubleday, New York 1967, p. 4.

into words. And even if we explain to a friend the characteristic features of a student he has to meet in a library, there is still no certainty he is going to find the one we intend him to meet. Here lies the question of the communicability of knowledge. We cannot adequately tell the content of what we know about the face about which we are talking. "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."[4]

Let us enrich the example of our capacity to know more than we can tell. It is not something exceptional that we catch the mood of a human face whether it is angry, happy or is engaging with a serious problem. We recognise the mood without being able to explain everything on the base of which our conviction is founded. We can indicate some clues, but if we are asked to specify the indications more precisely we will find difficulty to find exact words for our description. We can also refer to some specialists' experience from various subjects who teach students about their specialisation. Polanyi writes: "Great efforts are spent in practical classes to teach students to identify cases of diseases and specimens of rocks, of plants and animals. All descriptive sciences study physiognomies that cannot be fully described in words, nor even by pictures."[5] That is why a specialist often, after having explained the case with great attempts, eventually asks his students to keep the case as a task for a self–struggle and expedition. In the case of identifying diseases for example, even an expert specialist is willing to admit, "I cannot tell you how to recognise it; you will learn this by more extensive experience". Polanyi explains by comparing the complex activity in recognising a human face, that is physiognomy, with other kind of knowing involving our capacity to know more than we can tell:

> Clinical practitioners call the peculiar indescribable appearance of a pathological condition its *facies*; I shall call it a "physiognomy", so as to relate it to the delicately varied expressions of the human face which we can likewise identify without being able to tell quite how we recognise them. We may describe as a physiognomy also the peculiar appearance of a species which can be recognised only "aesthetically" and further include among physiognomies the characteristics of wines and blends of tea which only experts can recognise.[6]

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[4] M. Polanyi, *Knowing and Being*, p. 142.
[5] M. Polanyi, *The Tacit Dimension*, p. 5.
[6] M. Polanyi, *Knowing and Being*, p. 123.

The fact that we can know more than we can tell, rather than a lack of our capacity, is an important characteristic of our knowledge. Our mind, as it is obvious in perception, integrates our awareness of particulars into a comprehensive entity in the perspective of which we are not able to identify these particulars any more. This is an opinion of Gestalt psychology, and Polanyi is not reluctant to recognise the merit of such a viewpoint though he takes it with some reconsideration.

> ... my analysis of knowledge is closely linked to this discovery of Gestalt psychology. But I shall attend to aspects of Gestalt which have been hitherto neglected. Gestalt psychology has assumed that perception of a physiognomy takes place through the spontaneous equilibration of its particulars impressed on the retina or on the brain. However, I am looking at Gestalt, on the contrary, as the outcome of an active shaping of experience performed in the pursuit of knowledge. This shaping or integrating I hold to be the great and indispensable tacit power by which all knowledge is discovered and, once discovered, is held to be true.[7]

Polanyi reaches the idea of the process of tacit thought through the structure of Gestalt. Its scope now grasps the very largest range of our capacity manifesting in the tacit power of scientific and artistic genius. These are the highest form of integration. While those performed in the art of expert diagnostician and skills, whether artistic, athletic, or technical, are seen as somewhat impoverished discovery. However, there is no doubt that when he is speaking about knowledge, Polanyi means knowledge in its largest sense so as to include the two kinds of knowledge proposed by *Gilbert Ryle*, namely the "knowing what" and "knowing how".[8] The "knowing what" contains a more intellectual knowledge, while the "knowing how" is a more practical kind of activity. The latter includes various use of tools, of probes, of pointers, and the use of language. In spite of the difference in some points, the two kinds of knowing have a similar structure. That is why Polanyi writes: "I shall always speak of knowing, therefore, to cover both practical and theoretical knowledge."[9] Both involve the tacit procedure that integrates various particulars into a joint meaning of an object or an action.

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[7] M. Polanyi, *The Tacit Dimension*, p. 6.
[8] M. Polanyi, *The Tacit Dimension*, p.7.
[9] M. Polanyi, *The Tacit Dimension*, p.7.

The Confutation of the Ideal of Laplacean Goal of Science

The most ambitious reductionistic concept of reality is backed by the ideal of science held in our time. The obsession of science is to represent everything in terms of physics and chemistry; in other words, in a materialistic and mechanistic terms. Such an obsession has been introduced by Laplace which, according to Michael Polanyi, still remains as the most ruling ideal of science today. "The ideal of science remains what it was in the time of Laplace: to replace all human knowledge by a complete knowledge of atoms in motion."[10] We have seen how this ambition is applied within biology and psychology in the enthusiastic endeavour to explain life and consciousness in terms of physics and chemistry. The quantum mechanics theory, according to Michael Polanyi, is simply a branch of such a reductionistic project.

From the Topography of Atoms to the Perfect Knowledge

The purpose of science imagined by Laplace is to acquire a universal knowledge of the particulars of the universe so as to be able to predict exactly every event of the past as well as of the future. More precisely Polanyi writes: "Laplace affirmed that if we knew at one moment of time the exact positions and velocities of every particle of matter in the universe, as well as the forces acting between the particles, we could compute the position and velocities of the same particles at any other date, whether past or future."[11] In such an ambitious program the past and the future have no different value regarding the quality and the exactitude of knowledge that we can acquire about them. It assumes that provided that our minds are equipped with the information of the particles, theoretically the universe can be seen as a transparent vase containing no unpredicted and unexplained aspect.

It is precisely, according to Polanyi, the heart of the fallacy prevailing in science today. Knowledge is confined to the exact topography of all atoms constituting the known object. It is impossible, Polanyi points out, to arrive at a true knowledge without other element outside the topography of atoms, namely the part which we ourselves necessarily contribute. "The real fault in the kind of universal knowledge defined by Laplace is that it would tell us absolutely nothing that we are interested."[12] It turns to be a knowledge without spirit and

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[10]M. Polanyi, *Meaning*, p. 25.

[11]M. Polanyi, *Meaning*, p. 29. Again in *Personal Knowledge*, p. 139.

[12]M. Polanyi, *Meaning*, p. 29; see also *Personal Knowledge*, p. 141; see also *Scientific Thought and Social Reality*, p. 85.

is, for that reason, paralysed, and logically impossible. Indeed, our knowledge does not proceeds as such. If we want to know whether some primroses, that we plant today, will bear some blossoming next spring, our observation will not be focused, and need not be focused, on the atomic composition and its velocity at a certain moment. Our question about the primroses can be answered only in terms of primroses and not in the topography of atoms. Michael Polanyi writes: "The universal mind is utterly useless for this purpose unless it can go beyond predicting *atomic* data and tell us whether they imply the future blossoming or failure to blossom of the *primroses* planted today."[13]

Laplace however and those who share the same ambition with him are eager to substitute our experience with the atomic topography and hence explain all kinds of experience in terms of atomic data.

> The tremendous intellectual feat conjured up by Laplace's imagination has diverted attention (in a manner commonly practised by conjurers) from the decisive sleight of hand by which he substitutes a knowledge of all experience from a knowledge of all atomic data. Once you refuse this deceptive substitution, you immediately see that the Laplacean mind understands precisely nothing and that whatever it knows means precisely nothing.[14]

In other words, "Laplace's representation of the universe ignores all our normal experience and can answer no question about it."[15] The ideal of complete scientific knowledge is obviously not feasible, for it has no immediate relation with the vast majority of our experiences. "Indeed, his representation of the universe ignores as it stands most of our experiences instead of answering our questions in respect to them."[16] According to Polanyi, Laplace has misunderstood the very nature of experimental science by supposing that number and data of themselves point to events.

The way we use a geographical map to find our way reveals that such an assumption is untenable. A geographical map can be compared with experimental science in that both of them represent something of a deeper content. While a map represents a part of the earth's surface,

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[13]M. Polanyi, *Meaning*, p. 29.

[14]M. Polanyi,, *Personal Knowledge*: *Towards a Post-Critical Philosophy*, The University of Chicago Press, Chicago 1974, p. 141.

[15]M. Polanyi, *Meaning*, p. 29.

[16]M. Polanyi,, *Scientific Thought and Social Reality*, International University Press, New York 1974, p. 86.

experimental science represents a much more complicated element of experience. Nevertheless, none of them can be used in themselves without our tacit knowledge. To use a map as a guide to a certain destination we have to perform three things namely estabilising our actual position on the map, finding on the map an itinerary toward the destination, and identifying the itinerary by various landmarks in the landscape around us. Using a map then needs a right judgement of the user, for, as Polanyi writes, "no map can read itself. Neither can the most explicit possible treatise on map–reading read a map."[17] It tells us that a right judgement cannot simply rely on detailed data, but depends mostly on the tacit knowledge and skill of the person using the data.

The same condition prevails undoubtedly in the exact sciences praised by Laplace in his effort to define a universal and complete knowledge. It is exactly the target of Polanyi's criticism. In exact science, rather than using a map a scientist use formulas. There is no difference, Polanyi holds, of the way we use a map and relying on formulas in scientific procedure. Three similar stages can be found in scientific procedure in an interpretation of experience.

> First we make some measurements which yield a set of numbers representing our experience at the start; from these numbers we then compute, by the aid of formulas, a future event; finally, we look out for the experience predicted by our computation. At both the beginning and the end we identify numbers with observed events, and this too is a kind of map–reading, for which we must rely once more on our personal skill. Numbers do not of themselves point to events.[18]

Indeed numbers do not of themselves point to events. In reality however, the assumption of such possibility remains influential. Consider for example what happens in astronomy, held by Laplace, as a model of his ambition. Astronomers holding the Laplacean spirit think it possible to make an exact prediction of the position of the planets by the mathematical sciences. The objection of Michael Polanyi is as follows.

> You might think that Newton's laws could predict the exact position of the planets at any future moment of time. But this they can never do. Astronomers can merely compute from one set of numbers, which they identify with the position of a planet

[17]M. Polanyi, *Meaning*, p. 30.

[18]M. Polanyi, *Meaning*, p. 30; see also *Scientific Thought and Social Reality*, p. 86.

> at a particular time, another set of numbers, which will represent its position at a future moment of time. But no formulas can foretell the actual readings on our instruments. These readings will rarely, if ever, coincide with the predicted numbers as computed from Newton's laws and there is no rule—*and can be no rule*—on which we can rely for deciding whether the discrepancies between theory and observation should be shrugged aside as observational errors or be recognized, on the contrary, as actual deviations from the theory. The assessment in each case is personal judgement.[19]

Polanyi does not intend to underestimate all the scientific effort in understanding reality. Yet he does not accept the idea of a scientific knowledge based totally on the exact data of particulars. The tacit components must play a decisive role even in the formal and exact science. He notes that even a writer like Kant, who holds the strict rules of pure reason, admits an inscrutable faculty exercised in every act of judgement. Every time we identify something as a dog, cat, tree, and whatever else, we are performing a secret trick which is unlikely ever to be revealed to our understanding. Kant occasionally can only say that the way our intelligence forms and applies the scheme of a class to an individual thing is a skill so deeply hidden in the human soul that we shall hardly guess the secret trick that nature here employs.[20]

Science and Daily Knowledge

The obsession of building an ideal science cleaned of any informal knowledge is, for Polanyi, nonsensical. A Scientist never start his research from zero. The fundamental concepts of biology are necessarily based on every day experience in which measurement plays no part. "The existence of animals was not discovered by zoologists, much less by atomic physicists or chemist; nor was the existence of plants discovered by botanists. We learn to distinguish living beings from inanimate matter long before we study biology, and when we do

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[19]M. Polanyi, *Meaning*, p. 30.

[20]M. Polanyi, "The Unaccountable Element In Science", p. 1. Here Polanyi refers to the *Critique of Pure Reason*, where Kant writes about the *schema* of the concept as the conditions of sensibility, which constitute the universal condition under which alone the category can be applied to any object. According to Kant this faculty is an art concealed in the depth of human soul, and for that reason it is hardly possible to discover.

study it, we continue to use our original concept of life."[21] The same thing is equally valid in other fields of science. Before performing a psychological approach, one has to know from ordinary experience what intelligence is. Medical science as a task can be used only by ordinary people who know the suffering of sickness and the joy of recovery. Otherwise this performance will be disoriented and meaningless.

One may oppose this firm position by saying that science always develops and modifies our every day knowledge. It is true, Polanyi admits, but this fact does not cross out the fact that there still remains a vast range of everyday knowledge that serves as a guide to biology, medicine, psychology, and to various disciplines that study man and society. This kind of knowledge, according to Polanyi, are but a complex and delicate outcome of human experience transmitted by our predecessors in the form of practical arts. It is an art, for we are not taught any explicit rules in forming the idea and the concept we hold. Accordingly, there is no difference of how students are taught a scientific skill and an expert knowledge in the classroom, in the library, and in the laboratory. There is no expert who can exhaustively tell his listerners the knowledge he has acquired through his life and experiments. If he can, then there is no need of wasting time and money in building and use the laboratory in which the apprentices spend time and energy. In the last resort, an expert has to encourage his disciples saying "experience will teach you more." Laplace, in Polanyi's point of view, seems to forget this fact when he proclaimed his vision of the extreme idealisation of the exact science.

> To claim that a worldwide topography of atoms represents universal knowledge is to contradict the very principle of identification which must be used even in a mathematical theory if it is to bear upon experience. Hence, if the Laplacean vision or a similar ideal of the exact sciences succeeded in establishing itself as the total of man's knowledge, it would impose complete ignorance on us.[22]

The true attitude toward science, according to Polanyi, is understanding it in the context of skill and connoisseurship. In such an understanding we will see that scientific knowledge cannot be presented and limited in terms of exact rules and the knowledge of some amount of particulars.

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[21]M. Polanyi, *Meaning*, p. 32.

[22]M. Polanyi, *Meaning*, p. 32.

Informal Procedure in Science

When Polanyi emphasises the inadequacy of the complete knowledge of the particulars to establish our real knowledge of certain object, he opposes the strong ambition of reductionistic programme backed by the precise rules. It is generally held that the purpose of the exact science is to establish a complete intellectual control over experience in terms of precise rules which can be formally set out and empirically tested. Once that ideal rules are established formally, then our task is to follow them so as to be able to explain everything without error. In order to see the falsity of such an assumption, Polanyi makes an analysis of the role of the informal aspect in scientific knowledge.

Classification of Different Things

The main step on which science assumes to base its procedure are observation and testing. From several numbers of thorough observation and certain numbers of test scientists establish the law of nature. Polanyi describes his observation about this claim: "It is customary today to represent the process of scientific enquiry as the setting up of a hypothesis followed by its subsequent testing."[23] The question is how those scientists arrive at this formal procedure and how exactly they apply it? According to Polanyi there is always some aspect that cannot be specified in a specifically scientific procedure. In the introduction to his article *The Unaccountable Element In Science* he clarifies his purpose. He writes: "[...] I shall speak of the contributions made to scientific thought by acts of personal judgement which cannot be replaced by the operation of explicit reasoning."[24] This is something that escapes the scrutiny of formal procedure claimed in science.

Many thinkers, since Plato, have tried to explain the cognitive mechanism in applying the concept of class for certain individual things. Plato is the first troubled by this enigma. He noted that while we recognise the particularity of every single man, we still accept him as a man. Hence we apply to it a general idea of man. The problem is, how can we do this and what kind of man is the one to whom we apply all individual men? Plato has suggested that the man in question must be a perfect man without any particular characteristic. Because these characteristics mean imperfection, in his opinion an individual man is

[23]M. Polanyi, "The Unaccountable Element in Science", p. 12.
[24]M. Polanyi, "The Unaccountable Element in Science", p. 1.

just an imperfect copy of the general idea. The answer is genius, yet leaves the problem unanswered: what is the secret of identifying different individuals into a class?

At about 900 years ago Roscellinus suggested a solution to the paradox of identification within the framework of nominalism. He concluded that the word "man" is but a name of a collection of individual men. This however, according to Polanyi, offers nothing but a proof of the fallacy of the explicit rules in resolving the problem. Polanyi writes about this:

> But the indeterminacy reappears once more when we ask how to justify the labelling of a collection of different individuals by the same name and how, moreover, we can continue to label in a constant fashion, as time goes on, any number of further individuals differing in every particular from any individual thus labelled before and yet can continually exclude a vast number of other individuals as not belonging to the class we have labelled.[25]

Even Immanuel Kant, who is so powerfully eager to establish the rules of pure reason, eventually admits that in every act of judgement there involves some elements that cannot be grasped by the explicit rules. Polanyi obviously considers this submission as an acceptance of a kind of the tacit power of mind beyond our scrutinising endeavour. It is an art so deeply rooted in our soul so that we can hardly discover. However he regrets the systematic exclusion of this powerful mental agency from nearly every analysis of both Kant and his successors for fear of destroying the very base of the justification of knowledge in the framework of rationalism. "Perhaps both Kant and his successors instinctively preferred to let such sleeping monsters lie, for fear that, once awakened, they might destroy their fundamental conception of knowledge."[26]

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[25]M. Polanyi, *Meaning*, p. 52; see also *Knowing and Being*, p. 166 : "[...] his own view, that the word "man" is but the name for a collection of individual men, leaves open the question how we can justify the labelling of a collection of different individuals by the same name—a question that is further accentuated by our expectation that we shall yet be able to subsume under this label future instances of men differing in every particular from any man thus labelled before. The difficulty is not eliminated by specifying the characteristic features of man, since in doing so we must again repeatedly use one name for instance of a feature that are different in every particular."

[26]M. Polanyi, "The Unaccountable Element in Science", p. 2.

A more recent attempt to approach the question was launched in 1945 by F. Waismann. To understand the enigma of how we see a unity of different things, he suggested that a general terms has to be considered as having an open texture. Such an open texture, in his opinion, admits differences in the instances. This of course does not resolve the problem. According to Polanyi it simply shifts the problem rather than offers an solution. "For to ascribe "open texture" to a word is merely to imply that among an indefinitely extending series of different objects the word properly applies to some objects and not to the rest. The question how this is done remains open, exactly as before."[27] W.V.O. Quine seemed to be in a right direction when he was eventually encouraged to accept the conclusion reached by Kant, that the grounds on which instances are assigned to an empirical category of objects are inscrutable.

The acceptance of Kant's conclusion by Quine is seen by Polanyi as an acknowledgement of the power of our tacit integration that cannot be reduced. Any attempt to bring this activity to a reductive explanation has been misguided. The capacity to classify different objets, Polanyi insists, can be comprehended only if we acknowledge the role of tacit knowledge. He writes:

> Tacit knowing commonly integrates groups of particulars into their joint meaning. Members of a class such as a species, a family, or a language—or members of any other group properly denoted by a single universal term—possess a joint focal meaning when dwelt in as subsidiary clues to such a meaning, even though their focus is almost empty in contrast to a focal object of perception. Moreover, the meaning of a class is an aspect of reality, for it points to yet unrevealed joint properties of its members. If the joint appearance of disparate members of a class in the conception of a class should need support by analogy, think once more of binocular vision uniting two slightly different images in a single image of a different sensory character; or of the fact that the way we see an object integrates, among many other events in the body, innumerable memories beyond conscious recollection; or of a metaphor fusing two disparate ideas in a powerful joint meaning we have never before encountered.[28]

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[27]M. Polanyi, *Meaning*, p. 52; see also *Personal Knowledge*, p. 113.

[28]M. Polanyi, *Meaning*, pp. 52-53. This problem is also approached when Polanyi talks about the reinterpretation of language. He writes: "The adaptation of our conceptions and of the corresponding use of language to new things that

The problem of a universal term is of course a real problem of empirical induction. In fact each instance of a law differs in every particular from other instance of it. How, then, can a general law be strictly formulated from individual experience? According to Polanyi, it can be done only by relying on the tacit power. "Such indeterminately variable experiences can indeed be subsumed under the same law only by relying on our awareness of them as clues to it. And just as for perception, many clues of empirical induction will be easily identified in themselves, while many will not be and not all of them can be, identified."[29] Accordingly, the major part of scientists' hunches may be based on subsception. Here we see again what Polanyi means when he talks about science as a skill or as an art.[30] It tells us the difference between how a scientist and a non scientist see a reality. He writes: "And just as a keen eyesight enables one to discriminate objects that others cannot see, so does a gift of scientific discovery reveal natural laws in a scientific experience which signifies nothing to others not so gifted."[31]

Skill and art can only be mastered through example and personal experience in dealing with certain problems. There is no strict rules an expert may follow to transfer his expertise to his disciples. A new scientist, then, has to train his eyes, his mind, and his feelings so as to be able to pick up from certain various data the right clues to hit on the problem he is dealing with. With this in mind we are following Polanyi's

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we identify as new variants of known kinds of things is achieved subsidiarily, while our attention is focused on making sense of a situation in front of us. [...] The meaning of speech thus keeps changing in the act of groping for words without our being focally aware of the change, and our groping invest words in this manner with a fund of unspecifiable connotations. Language is the product of man's groping for words in the process of making new conceptual decisions, to be conveyed by words." (*Personal Knowledge*, p. 112).

[29]M. Polanyi, *Knowing and Being*, pp. 166-167.

[30]Polanyi describes the equality of the formation of classification of different things and the discovery of natural laws. Both are based on the process of tacit knowing. "I am interpreting the formation of class concepts (along with the discovery of natural laws) as based ultimately on a process of tacit knowing, the operations of which I have exemplified in the learning of skills, the recognition of physiognomies, the mastery of tests, the use of tools, the uttering of speech, and the act of visual perception. The powers of integration which achieve these acts have the same structure throughout." (M. Polanyi, *Knowing and Being*, p. 167).

[31]M. Polanyi, *Knowing and Being*, p. 167.

idea that the establishment of the law of nature is based on an unexplicit procedure.

Puzzlement and Insight in Scientific Explanation

The informal procedure as an integral part of science can be seen also in our experience in capturing an understanding of a puzzling event. Polanyi notes that the way in which we produce a scientific explanation depends on our propensity to be puzzled. There are indeed different views of how certain events have to be considered as puzzling. One radium, for example, may decompose today while another one perhaps fifty years later. For most physicists it is nonsensical to be puzzled by such a difference in time, because there is no explanation for this fact. Some argue that it is nonsensical to be puzzled by events which, though they may be explicable in principle, are not ripe for explanation or are not worth the trouble of explaining. Other scientists, however, hold a fundamental difference of opinion by accepting such a different event of decomposition as puzzling. We see then that being puzzled implies a selective judgement. For Polanyi indeed, notwithstanding the variations of the advisability of being puzzled, a scientific explanation must serve to dispel puzzlement.

Establishing an explanation is only one approach to release tension of being puzzled. Polanyi even believes that an explanation can be well understood in the light of another means, that is insight or understanding. What is the difference between these two approaches? Let us see what Polanyi tells as an example.

We may be puzzled by the way an intricate piece of machinery is constructed and the way it works or by the structure of a huge building in which we are loosing our way. In such a situation our main urge goes directly to get understanding or insight rather than searching for explanation. Our first aim is to catch the whole particulars of the object or the event and attain through them a joint meaning. More precisely, Polanyi writes:

> What we are seeking here is an understanding of the machine or the building—an insight into them, but not an explanation. Such insight is a particular type of tacit integration that has not yet been mentioned. Its subsidiary items are the particulars of the complex entity—the machine, or the rooms in the building; and when we integrate these particulars and thus bring out their joint meaning, their puzzling aspect is transformed into a lucid image. Our puzzlement in these cases is relieved by an insight which is

> itself simply our own meaningful integration of the parts of the complex entity.[32]

Obviously, the act of insight is not an image that can be laid down on a sheet of paper. Its aspects are too rich to be able to be presented on a plain surface. Every particular we write on the paper can just offer a tiny clue of a much more deep aspect of a three dimensional reality such as the anatomy of a complex living thing, or a complex arrangement of geological strata, or a complex arrangement in crystals. Only a powerful integrating activity of the mind, that is insight, that leads us to dwell in such tiny clues and through them to capture their joint meaning. "Only by combining such aspects in the imagination can a three–dimensional understanding of the aggregate be achieved. Such insight is a purely mental fact, like any other focal target, comprising a large number of subsidiaries."[33] For that reason, according to Polanyi, insight is different from the focal target in a stereo vision, in reading a sentence, or in probing a cavity. As it has been noted, the focal target of a stereo vision lies away from the subsidiary. In insight however, the focal target coincides in our imagination with its parts.[34]

Insight is something beyond the power of articulation. Wolfgang Köhler has noticed an interesting behaviour performed by a chimpanzee dealing with a rope wound loosely twice around a pole. The chimpanzee, wonderfully, did not pull the rope blindly at its end but went around the rod so that the string is unwound and disengaged. The chimpanzee, Köhler concluded, has a clear idea to resolve the problem, to disengage the string by rendering it unwound. Polanyi sees it as a manifestation of insight performed by the chimpanzee. Human thought proceeds in a relatively equal procedure in confronting a certain puzzling situation which immediately prompts us to make a basic question as to how it works. Such a question guides us to find an insight, a deep understanding of the situation. It is in the light of the similar question that a scientist goes on immersing into his subject and discovers the law of nature. Polanyi indicates some examples:

> [...] we understand living things, the functioning of their organs and the working of their intelligence, by an act of indwelling, which is also an act of insight. Similar insight is involved in taxonomy, which orders biological specimens much as X–ray

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[32]M. Polanyi, *Meaning*, pp. 53-54.

[33]M. Polanyi, *Meaning*, p. 54.

[34]The *Collins Cobuild English Dictionary* defines insight as an accurate and deep understanding of a complex situation or problem.

> crystallography does in establishing the space group to which a crystalline specimen belongs.[35]

It is also insight which guides to the discovery of Kepler's planetary laws.[36] If insight precedes explanation, then it must also play an important role in scientific explanation. An explanation assumes a submission to a general law as its base that can be attained only in an insightful activity. It is precisely what happens in a recognition of inference in nature. "The possibility for extending the recognition of inference in nature consists in subsuming a natural law within a more general law of which it is a special case."[37] About this Polanyi seems to agree with some modern philosophers such as J. Stuart Mill, Carl G. Hampel, Oppenheim, and Ernest Nagel. He reminds, however, that to limit an analysis of such a vast area to its fragments may obscure the subject. In Polanyi's opinion, it is such a case which is practised in the behaviouristic explanation, in which the obsession of a strictly formal approach, reduces the explanation to a merely formal subsumption of a natural law under a more general law. The actual subject matter in this approach is restricted to a fragment found suitable for the formalisation. Such a formalisation, Polanyi notes, "if carried out strictly, produces a result that is strictly, in itself, empty of any bearing on the subject matter; but by calling it an "explanation", one imbues it with the memory of that informal, insightful act of the mind which it was supposed to replace."[38]

What we see in such a replacement is a kind of *pseudosubstitution*. In one side there is a formal act of denying the mental powers here, while at the same time its ultimate consequence is avoided by borrowing the qualities of the powers formally tempted to eliminate. Such is the danger of the idea of scientific explanation held as separated from the power of the mind and even eliminates the role of the mind itself. "A pseudosubstitution is a gesture of intellectual self–destruction that is kept within safe bounds by its inconsistency."[39] Our culture, in Polanyi's opinion, is pervaded by such intellectual subterfuges.

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[35]M. Polanyi, *Meaning*, pp. 54-55.
[36]M. Polanyi, *Meaning*, p. 54.
[37]M. Polanyi, *Meaning*, p. 55.
[38]M. Polanyi, *Meaning*, p. 55.
[39]M. Polanyi, *Meaning*, pp. 55-56.

Empirical Generalisation

The informal procedure applies also in an empirical generalisation within the pursuit of science. This aspect, however, seems to loose within the shadow of the claim of strict criteria and formalisation. Polanyi points out three indication that lead to such a misleading idea. First, there is no strict criteria through which we can establish the idea of the exact starting point of an inquiry. This kind of shortage tempts philosophers to abandon any endeavour to understand how it is done. The second seems to be contradicting. Although philosophers arrived at the conclusion that no formal rule of inference can establish a valid empirical generalisation, they deny after all that the generalisation can be derived from experimental data. They ignore the fact that valid generalisations are commonly arrived at by empirical inquiries based on informal procedure. Third, some philosophers claim that a hypothesis will be immediately left if it is found conflicting with a single evidence. Such a claim, in Polanyi's view, is untenable. The claim that a scientist will immediately abandon his former claim when he notices a contradictory information, is far from the experience of how discovery is made. Moreover, a contradictory piece of evidence cannot be formally identified.[40]

In his work, *Science, Faith and Society*, Michael Polanyi delineates for the first time his idea about the informal powers which guide not just the pursuit of science but also provide criteria for accepting its result. He shows us the process by which we usually first establish the reality of certain things around us. How do we perform this? Polanyi writes: "Our principle clue to the reality of an object is its possession of a coherent outline."[41] Gestalt psychology, he admits, offers us an idea of our remarkable performance involved in perceiving shapes. In observing a ball or an egg, for example, we see their shapes at a glance. The case, however, will be different if the impression made on our eyes by the aggregate of white points forming the surface of an egg is substituted by another presentation of these points as given by a list of their special co-ordinate values. In the absence of guessing, years of labour would be needed before the shape inherent in that aggregate could be discovered.

We can conclude then, following Polanyi's conviction, that the capacity to perceive the shape of an egg at a glance, from the list of co–

[40]M. Polanyi, *Meaning*, p. 56

[41]M. Polanyi, *Science, Faith and Society*: *a Searching examination of the meaning and nature of scientific inquiry* (2nd edition), The University of Chicago Press, Chicago 1964, p. 24.

ordinate values, is similar to the intellectual power performed by scientists that guides to a great discovery such as the Copernican system. "We can say," he writes, "that the capacity of scientists to guess the presence of shapes as tokens of reality differs from the capacity of our ordinary perception, only by the fact that it can integrate shapes presented to it in terms which the perception of ordinary people cannot readily handle."[42] The scientist's intuition trained in his expertise can consider some dispersed information and data—seen in ordinary sight as irrelevant—as clues for a certain shape. Through his sharp and well trained intuition, a scientist can arrive at a meaningful integration from particulars which for others might seem meaningless and offer no idea of the possibility lying ahead.

This does not mean that the result achieved by such intuition cannot hit an erroneous path. Indeed, a scientific perception may be erroneous, just as our daily perception may misperceive a camouflaged body. The main point of Polanyi's concerns here is the impossibility of reducing the proposition of science to merely a formal procedure. "I am concerned here," he asserts, "only with showing that some of the characteristic features of the propositions of science exclude the possibility of deriving these by definite operations applied to primary observation; and to demonstrate that the process of their discovery must involve an intuitive perception of the real structure of natural phenomena."[43]

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[42]M. Polanyi, *Science, Faith and Society*, p. 24.

[43]M. Polanyi, *Science, Faith and Society*. pp. 24-25. Here Polanyi admits a kinship between perception and scientific discovery as it has been previously suggested by Poincaré, Hadamard, and Polya. Later he finds more confirmation of this position from J.B. Conant, Thomas S. Kuhn, and Leonard K. Nash. See also *Meaning*, p. 56.

Conclusion

The main concerns of Michael Polanyi as shown above is the nature of scientific knowledge related with the idea of how scientists work. Scientific knowledge is a human activity, and according to this very basic principle it cannot be pursued in a totally detached and objective procedure. There is always personal participation in scientific activity. The personal participation held by Michael Polanyi as the elemental contribution of the knower in his act of knowing is equally as effective in scientific knowledge as it is in the daily knowledge, in art, in religion, and in the rest of our culture. The anticipation of reality, intuition, and imagination, for example, are indispensable in the process that leads to a scientific discovery. It is clearly held that such participation is an indispensable contribution rather than a defect to the scientist's activity in pursuing the truth.

Accordingly the idea of science offered by Michael Polanyi has an anthropological aspect, for it continuously reminds us of our important role in exploring the hidden aspect of reality. By espousing the role of personal aspect, Michael Polanyi does not intend to obscure the meaning of objective reality as something outside there and considers it as mere intrapersonal entity which is specific to a given knower. For him, the ultimate criterion of the objectivity is of course the reality itself. He is dealing, however, with the way we reach reality; in other words, how we know and how scientists work.

The epistemology offered by Michael Polanyi was moved by his belief that there are so many kinds of human suffering caused by the false idea of knowledge, especially scientific knowledge. For him science is a human activity dealing with the nature of reality. According to R. A. Hodgkin, it is such a view of what scientist is that makes his idea of science particularly attractive today[44]. As a human activity, though, science cannot work by itself, and it is even meaningless without any participation of the scientists who understand and interpret the theories and the data offered by science. This may seem eccentric, for as long as we follow the ruling idea of science of our time, every human bias intervening in a scientific procedure is considered as a defect and hence is to be abolished. It is generally held, that scientific knowledge surpasses any other kind of

[44]R. A. HODGKIN, 'Michael Polanyi', *Convivium*, 4 (Summer 1977), p. 11.

effort to understand reality for its strict criterion to rule out much of human participation. In such perspective, science in itself is claimed to be the main factor in offering knowledge of reality, while scientists are no more than obstacle.

Science for Polanyi is the activity of human beings, namely the scientists. Its process, persistence, and development in the scientific society all require an enthusiastic participation of the scientists. When Michael Polanyi explicitly opposes the motto of The Royal Society, *nullius in verba*, which means the refutation of authority, and Bacon's claim that science was to be based on purely empirical methods, he invites us to re–establish our place in scientific effort; and to oppose the dictum that in science facts alone count. When we say that science is a human activity we acknowledge the importance of the human factor, that is the creative involvement of the scientists, in selecting, interpreting and integrating the data in a scientific framework. Unlike a truth-finding machine, automatically collecting empirical data, a scientist is a creative actor in his scientific activity. There is no exact rule that can securely lead to the solution of a problem. Neither the availability of complex data can guarantee the solution of a problem and the attainment of a great discovery without the creative involvement of the scientists. In this sense, scientific activity is an art. All that can be done by a scientist is to rely on his personal tacit power which integrates the available data while he is exploring the hidden aspect of reality. ***

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