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CONVIVIUM

(Michael Polanyi Newsletter)

This will be the last edition of Convivium in its present form, although it is hoped that it can continue in a lower key as a news sheet which will keep members in touch with each other, and perhaps circulate and inform people about research papers, books, lectures, etc.

Convivium has acted not only as a means of communication between members but our small committee has over the years organised a number of conferences, weekends, and meetings on the works of Polanyi and related areas of interest on our own and sometimes in conjunction with other organisations. The committee has gradually changed over the years but Drusilla Scott as Chairman has provided a unity of interest and tactfully kept us all to our task, and Patricia Smart has done stalwart work as Secretary and occasional last minute organiser of conferences. Many thanks to Lady Scott and Miss Smart in particular but to all past and present members of the committee for the help given to me as editor of the newsletter and treasurer of our group.

Miss Joan Crewdson has kindly offered to continue to produce the newsletter, and keep us in touch with each other if there remains an adequate response (See letter).

Robert Brownhill

Editor

Dear Members,

As a result of our request for subscriptions and comments about the future of Convivium, we have had the following responses:-

Twenty eight people have sent a subscription, including fourteen of more than the minimum £1.

Thirteen people commented on the future of Convivium of who eleven thought it would be good to form a Michael Polanyi Society and two thought Convivium should continue as it was.

This means that at least fifty four people will cease to be on our mailing list and that we will probably have a total membership of around thirty..five including present committee members.

It seems doubtful to me whether we are justified in continuing on this basis. I predict (my personal view only) that only an immediate response from the silent majority will prevent the committee, from deciding regretfully to wind up Convivium.

Yours sincerely,

Joan Crewdson

Membership Secretary

Note

We have again included a subscription form with this edition of Convivium but remember that at best it will be for a lower key newsletter with the object of providing a focus of information for interested people, there would be a list of subscribers with their area of main interest in Polanyi; notices of relevant meetings and conferences, short notices on books and articles. There would be no formal committee but perhaps it would be possible to hold a forum or meeting once a year.

Editor

Books

# 1343

David Holbrook, English for Meaning , NFER, 1980.

Holbrook claims that the Bullock Report on literacy could have the effect of directing the teaching of English into a disastrous dead end. The Bullock Report, says Holbrook, suggests that to teach English one must know linguistics, and be able to know explicitly what goes on when a child uses words. But this is a massive irrelevance and a major diversion from the proper imaginative basis of language skill. A child employs intuitive facilities which are natural to him but which cannot fully be made explicit or controlled..

In this book Holbrook is concerned to defend the creative, imaginative basis of English teaching which flourished in the fifties and sixties but has now been eroded by the fashion of linguistics.

He goes on to show that there is a neglected philosophical basis for English teaching in the 'philosophical anthropology' of D.W.Winnicott, Martin Buber and Michael Polanyi, who stress the natural need of the child to make an imaginative exploration of the meaning of his existence. What this involves Holbrook shows by reporting on his own teaching of creative writing, poetry, and fiction. English teaching must deal with the questions, 'What is it to be human?' and 'What is the point of life?' To reduce it to mere attention to 'language use' is a betrayal of the obligation of the humanities.

Douglas R.Hofstadter, Gödel, Escher, Bach: an eternal golden braid, Basic Books, New York, 1979.

This review was sent in by Robin Hodgkin.

# 1344

Review Article

Jumping to a Richer Field

A Reading of Gödel, Escher, Bach.

Douglas Hofstadter's tour de force has been greeted with cries

of both ecstasy and suspicion. But his profound interest in Godel, his inspired insights into the common ground which exists between number theory and the ordered creations of two great artists and the confidence with which he creates his own bold synthesis - all these should attract students of Polanyi. For Polanyi was one of the first philosophers to see the central importance of Godel in any world view capable of comprehending the hierarchical nature of being and knowing. Both men have attempted, in different ways, to throw a bridge across that long and wavering crevasse which has, for three centuries, split thought from action.

I am not a logician nor do I know enough mathematics to do justice to parts of this book. But Hofstadter is so interesting, so dashing, and touches on so many Polanyian themes that it is hard not to be drawn into the discussion. So I here put forward a few notes and observations which may encourage others to look at the common ground of two bold thinkers. First of all it must be noted that Polanyi gets a brief and doubly incorrect mention by Hofstadter. He calls Polanyi 'a holist par excellence' which may be accepted, but he also calls him 'a biologist', which inevitably shakes one's confidence in some of his numerous other glosses. He also lumps Polanyi with Eccles, as though they were both to be regarded as dualists. Yet Polanyi and Hofstadter share that heroic monism which, while being rooted firmly in a rational and incomplete world of science, is nonetheless able to accept the possibility of vast and almost infinite mysteries, provided that in principle and in the long run these are open to Mind.

In an enthusiastic and excellently illustrated review in the Scientific American (July 1979) Martin Gardner sums up the Kernel of Godel, Escher, Bach when he asks 'what central reality is it that these three giants share.

One aspect of that reality is the formal structure of mathematics: a structure that, as Godel's famous undecidability proof shows, has infinitely many levels, none of which are capable of capturing all truth in one consistent system. Hofstadter puts it crisply. 'Provability is a weaker notion than truth! In any formal system rich enough to contain arithmetic true statements can be made that cannot be proved within the system. To prove them one must jump to a richer

system, in which again true statements can be made that cannot be proved, and so on. The process goes on for ever.

Some readers may be put off by the light-heartedness of C.E.B. and by the author's relentless exploitation of paradox and verbal coincidences. Much of it is inspired by Lewis Carroll and the influence of Zen Buddhism is strong. The dialogues which are fitted between each chapter are brilliant and undoubtedly serve to make the hard bits easier. In the following notes I shall indicate a number of themes which seem to me to be of exceptional interest to students of Polanyi and on some I will make a tentative comment. I then attempt to sketch out what seems to be the theme of the latter part of the book and - comparing it with Personal Knowledge - suggest what may be a central shortcoming.

1. Number Theory. I learnt a lot from trying to follow Hofstadter's elementary exercises but always gave up when they became demanding. Chapter Vlll, for example, is about Typographical Number Theory - the kind of meta-logic in which Godel works - but one can get the gist of it.

2. Levels .P286 and 287 are reminiscent of Polanyi's 'Logic of Tacit Knowing' - the four stages, etc. 'A gifted mathematician doesn't usually think up and try out all sorts of false pathways to the desired theorem, as less gifted people and computers do; rather he just 'smells' the promising paths and takes them immediately.' Smells? Yes, he gropes from a lower to a higher level.

Usually we are not required to hold more than one level of understanding in our mind at once. Moreover, the different descriptions of a system are usually so conceptually different from each other that .... there is no problem in maintaining them both ..... in separate mental compartments. What is confusing, though, is when a single system admits of two or more descriptions on different levels which nevertheless resemble each other in some way .... Undoubtedly this happens when we think about our own psychology - for instance when we try to understand people's motivations for various actions ... for instance, we talk of "drives"- for sex, for fame, for power, for love, etc., etc., - without

knowing where these drives come from in the human mental structure .... Our confusion about who we are is certainly related to the fact that we consist of a large set of levels, and we use overlapping language to describe ourselves on all these levels. (p.287)

Hofstadter is also extremely interesting on artificial intelligence. He takes issue very vigorously with John Lucas on this and kindred matters. And he makes clear an important point about the sophistication of different computational levels. What makes for high-level performance in a machine - i.e., one which approaches intelligence- is not so much the machine as the language used in the machine. Hofstadter is, in principle, both a reductionist and a holist.

There are probably three or four dozen languages which have been developed exclusively for Artificial Intelligence Research. It is important to realise that any programme which can be written in one of these languages is in principle programmable in lower level languages, but it would require a supreme effort for a human [comparable to specifying the state of every neuron associated with a thought]. It is not that each higher level extends the potential of the computer; the full potential of the computer already exists in its machine language instruction set [i.e. its mechanicalness]. It is that the new concepts in a high level language suggest directions and perspectives by their very nature. (p.299)

3. The Ant Colony. This comes in the dialogue with the ant eater and it presents a fascinating model of how the meanings and messages of a macro-system transcend, and may even appear to be callous about, the swarming activities of its components. Here Hofstadter begins to take symbols very seriously. In this, I think, he has something important to add to Polanyi's way of thinking. (Ant Fugue p.311-336.)

4. Symbols. Hofstadter uses the word 'symbol' in a wide, but crucially important, sense - as a meaning-generating pattern - of colours, shapes, sounds or neurons. So it becomes, in his hands, a two-sided concept which can refer both to the hypothesised patterns of neurons acting collectively and to the dimly perceived, 'subjective' patterns of meaning which may be triggered, for a

reflective person, by art, ritual music or dream. It is a bold move not only to accept the teutonic connotation of symbol (following Cassirer, Jung, Langer), as opposed to the safer, Gallic usage (Piaget and many linguists) which more or less conflates 'symbol' and 'sign', but Hofstadter<sup>90es</sup> further and grounds dynamic symbols in neuro-physiological activity. He is, however, quite emphatic, in discussing this, that he is not talking of the firing of individual neurons or of isolated brain circuits but he is referring, rather, to an assumed macro-level (or levels) in which we must imagine thousands or millions of cells acting in harmonious concert - or in pathological discord. From a Polanyian standpoint, therefore, we see him using his knowledge of computers, logic, A.I., music and the graphic arts to suggest how the processes of tacit knowing might be conceptualised.

Hofstadter has been discussing the great difficulty of simulating human situations in computer programmes for there is always so much more to any situation than we can articulately tell. He can then proceed to bring together tacit knowing and symbols in a passage reminiscent of Polanyi;

It seems that a large amount of knowledge has to be taken into account in a highly integrated way for 'understanding' to take place. We can liken real-world thought processes to a tree whose visible part stands sturdily above ground but depends vitally on its invisible roots which extend way below ground, giving it stability and nourishment. In this case the roots symbolize complex processes which take place below the conscious level of the mind--processes whose effects permeate the way we think but of which we are unaware. These are the 'triggering patterns of symbols' which [we have] discussed. (p.569)

He has stressed, elsewhere, that for this kind of 'process thinking' new concepts will have to be developed and also a new mobility of perspective; while at the same time, critical vigour will have to be sustained if we are to make headway. He certainly shows agility when he comes to compare, in close detail, the operations of genetic language - DNA, RNA and their activity or meaning) in the building of cells - with human

language - word strings, mathematical notation and the generation of closed and open logical theorems. This leads to what he calls his 'Central Dogmap' (p.533)

Looking back on Godel, Escher, Bach I felt rather as I did after a first reading of Personal Knowledge- that I had been on a strenuous journey and had only just made it. But there was a difference. Both books take you backstage. You see strange loops and pulleys hanging from - you're not sure what, and you see scenes within scenes, mirrors and inversions, trap doors and shadowy technicians padding about their business. Hofstadter tells you even more than Polanyi does about how it all works - or might work. But with G.E.B. you scarcely ever feel that the theatre might be the context for a drama which transcends it, that there might be a central symbolic core, a play in which, when the analysing is over, you might have a small part. With Personal Knowledge it is otherwise. Though Polanyi rarely indicates a costume or a script, you know, by the time you have finished, what kind of a mystery play the theatre was built for, and what kind of a person.

Robin Hodgkin

Article

4/395

Polanyi and Leavis

In the Summer number of the British Journal of Aesthetics, Peter Byrne discussed a critic of F.R.Leavis, who had taken the line that Leavis should set out his theory of how literature is to be criticised, before doing the criticism. This critic's view implied that we need to see the rules clearly stated, the criteria spelled out and defended, so that we can understand the world view on which they rest. Particular judgments, in his view, should be justified by reference to some set of general principles, explicitly detailed.



Peter Byrne defended Leavis, but suprisingly, without mentioning Polanyi, the philosopher whom Leavis quoted and explicitly admired. (See , The Living Principle, p.64, "Polanyi's originality is very impressive, and (that) its influence, if it has the influence it deserves, would make it of the greatest importance.") Yet it is by Polanyi's philosophy that the Leavis method can be the most clearly understood and be seen to be justified.

Leavis, says Byrne, is not arguing that general principles are not involved in criticism, but that the general principles cannot be grasped except through a grasp of the particular judgment. Principles applied as rules are blunt and cumbersome instruments for making individual judgments ~~for making individual judgments~~. The Leavis method is to take actual examples and place them in a range of other examples, so that the grounds of the judgements become apparent. Byrne quotes the example of law, preserved and modified through precedent and interpretation; an example Polanyi often used. Byrne defended Leavis against the charge that he was trying to escape from scientific rigour ; rigour is not the same as explicit principles, and principles need judgment to apply them.

This is very much Polanyi territory. And the more one reads of Leavis, I find, the more beautifully his methods of criticism are found to illustrate Polanyi's thought. This is the more impressive because he did not derive his methods from Polanyi, but found in Polanyi confirmation of what he had independently discovered.

Polanyi wrote of the universal standards 'of artistic creation, self set standards yet ultimate - "Actually these standards themselves would have been established, as all principles are, by the valid work done under their control. They would not have been chosen by a deliberate act ( even a responsible one) before meaningful work had been done under their control .. new principles come into existence as part of the subsidiary clues establishing a new coherence. Only after this new coherence had been established is it possible to see what the new principles are which ground it ...

Whenever we are faced with the necessity for deciding on a judgment, we cannot avoid relying on ultimate criteria .. The point is ,however, that we are often unaware of what these criteria are until after we have relied on them as subsidiary clues to a focal integration." (Meaning, p.103)

The support which this gives to Leavis is the stronger because it was in the field of science that Polanyi first established this primacy of skilled practice over explicit rules. It is stated for instance in the appendix on the Premises of Science in Science, Faith and Society , "The premisses of science cannot be explicitly formulated, and can be found authentically manifested only in the practice of science, as maintained by the tradition of science." As Polanyi says elsewhere, the principles of an art are more truly embodied in its practice than in its maxims.

I want to be brief so can only indicate some of the ways which Leavis and Polanyi bear out each other's insights. I would choose as the first example the idea of a living tradition, both authoritative and developing, within which individual creative discovery is possible. This idea is found passim in Polanyi; I would quote for example from Science, Faith and Society the piece about general authority such as prevails in science, "A General Authority relies for the initiative in the gradual transformation of tradition on the intuitive impulses of the individual adherents of the community, and it relies on their consciences to control their intuitions ... such a regime assumes that individual members are capable of making genuine contact with the reality underlying the existing tradition and of adding new and authentic interpretations to it."

We can compare with this a Leavis piece from The Great Tradition about Jane Austen: "In fact Jane Austen, in her indebtedness to others, provides an exceptionally illuminating study of the nature of originality, she exemplifies beautifully the relations of 'the individual talent' to tradition. If the influence bearing on her hadn't comprised something fairly to

be called tradition she couldn't have found herself and her true direction; but her relation to tradition was a creative one. She not only makes tradition for those coming after, but her achievement has for us a retroactive effect. Her work, like the work of all creative writers, gives a meaning to the past." And in The Living Principle Leavis writes of, "The full necessity of a living creative literature, of the cultural continuity without which there can be no valid criteria of the humanly most important kind." Again in Nor Shall My Sword he wrote of "that continuous collaborative renewal which keeps the heritage of perception, judgment, responsibility and spiritual awareness alive, responsive to change and authoritative for guidance."

Secondly I would mention the complex of ideas which links creativity with a personal responsibility to reality, thus showing personal judgment can be objective. These ideas are found throughout Polanyi's work. From Leavis I would quote this example from Nor Shall My Sword: "The Blakean sense of human responsibility goes with ... realisation that without creativity there is no apprehension of the real, but that if experience is creative, the creativity .... is not arbitrary; it is self dedication to a reality that we have to discover" .... "The artist's creativity is always concerned for the real." ... "The artist in his creativity is conscious of being a servant."

I will comment on one more aspect of the relationship of Leavis and Polanyi; the different degree of indwelling and personal participation needed in knowing different levels of reality. A Polanyi example; this passage from The Study of Man:

"Now take into account also that the participation of the knower in the thing he knows increases steadily as the objects of knowledge ascend to ever higher levels of existence, and that, correspondingly, the observer also applies ever higher standards of appreciation to the things known by him ... when we arrive at the contemplation of a human being as a responsible person, and we apply to him the same standards as we accept for ourselves, our knowledge of him has definitely lost the character of an observation and has become an encounter instead."

Leavis in The Living Principle can be quoted in comparison, "Major creative writers are concerned with a necessary kind of thought ... the thought in question is antithetically removed from mathematics; it requires a full consciousness of one's full human responsibility." Such thought needs a community. Speaking of objectivity, Leavis remarks, "Hume and Russell are not authorities on it.", and he shows how objectivity about persons needs the great writer's "intense and delicate interest in human nature". He does not use the term 'indwelling', but that is the way of knowing persons which all his work implies - not the uniformity which sociologists might seek, but the sympathetic imagination by which we can share the mind of an individual, while seeing in it the quality which relates it to the universal.

Reading Leavis does not induce the view that the study of literature calls for less rigour than the study of science. And Leavis has the same feeling for the risk and daring of commitment as Polanyi. "The only way", he says at the beginning of The Great Tradition, "to escape misinterpretation is never to commit oneself to any critical judgment that makes an impact - that is, never to say anything. I still, however, think that the best way to promote profitable discussion is to be clear as possible with oneself about what one sees and judges, to try and establish the essential discrimination in the given field of interest, and to state them as clearly as one can (for disagreement if necessary)." While Polanyi begins his chapter on Commitment in Personal Knowledge, "I believe that in spite of the hazards involved, I am called upon to search for the truth and state my findings."

Drusilla Scott

# 1396

## Niels Bohr and Michael Polanyi: Some Interesting Parallels

The writings of Niels Bohr have stimulated considerable interest among physicists and philosophers of science.<sup>1</sup> Bohr's early work in atomic physics had a profound influence on the development of quantum theory, and his principle of "complementarity" became one of the key ideas in the later "Copenhagen School" of interpretation of the quantum-mechanical formalism. Yet recent studies have revealed profound differences between Bohr's own ideas and those of his colleagues (Heisenberg, von Neumann, Jordan and others).<sup>2</sup> As a consequence, Bohr remains a rather isolated and enigmatic figure on the fringe of contemporary philosophy of science and has had very little influence on philosophy as a whole. His ideas arouse suspicion, often open hostility, as being anything from positivist to mystical; at any rate incomprehensible.<sup>3</sup> My concern in this paper will be to suggest a new approach to his thought based on a comparison with the writings of Michael Polanyi.

Like Bohr, Polanyi was a physicist interested in the broader problems of philosophy. His ideas have received a wide hearing, especially among those with anti-reductionist or existentialist sympathies.<sup>4</sup> However, many philosophers and scientists have difficulties with what appears to be an uncontrolled tendency towards mysticism and subjectivity in his thought. In my own work, I have found that a comparison with Bohr's ideas provides a useful frame of reference for understanding and appreciating some of Polanyi's more elusive concepts. In other words, the two thinkers help to illuminate each other and together provide an interesting paradigm which could be of some use to contemporary philosophy.

### The Use of a Stick as a Probe

The difficulty of comparing two thinkers like Bohr and Polanyi is that many of their concepts are rather intuitive, not precisely

defined, and the terms used to convey these ideas are completely different. Fortunately, however, a Rosetta stone is available in that both men treat the use of a stick as a probe as a concrete illustration of their ideas. By starting with this illustration it is possible to establish a correspondence between their respective terminologies. Furthermore, the concreteness and familiarity of the illustration allows us to grasp the empirical content of their thought and to spot significant differences in their approaches.

As Bohr explains it<sup>5</sup>, a stick must be held firmly if it is to be used as a probe. When it is held properly, the stick functions as an extension of the arm, and the subject is aware of the impressions being made at the far end where the stick comes into contact with the environment. Conversely, when the stick is held loosely in the hand, the subject is only aware of the stick itself; it no longer serves as a probe. So the subject has a choice between investigating the stick (holding it loosely) and using the stick to investigate the environment (holding it firmly). Of course, he may do each in turn, but he cannot do both at the same time as the conditions required are mutually exclusive.

In Polanyi's version<sup>6</sup>, there is no difference in the handling of the stick, yet the net result is the same. It is when we first attempt to use a stick in this way (presumably as children) that we are aware only of the feeling of the stick in our hands. With practice, however, we learn to integrate the sense-impressions and transfer our attention to the far end of the stick and the environment beyond. At this stage the stick begins to function as an extension of the human body, as a probe, in other words. With a little effort we can still fix the focus of our attention back to the near end of the stick and the impressions it makes on our hands, but the two forms of awareness are mutually exclusive as with Bohr. The difference is that Bohr stresses the objective handling of the stick, reflecting his concern with experimental arrangements in physics, whereas Polanyi stresses the mental attitude of the subject, reflecting his interest in Gestalt

psychology and learning theory.

Having established a point of contact between Bohr and Polanyi in this homely illustration, we may proceed to compare the respective ideas which it is used to illustrate. I shall be brief and schematic as the intent is to focus on the parallels between Bohr and Polanyi rather than give an exhaustive treatment of either one.

### Bohr's Epistemology

#### (a) Analysis and application.

Through out his writings Bohr stresses the contrast between "analysis" and "application".<sup>7</sup> As in the case of the probe, any tool or artifact may be analysed as an object in its own right, or else it may be applied in the manipulation or investigation of something else.<sup>8</sup> "Analysis" and "application" are mutually exclusive alternatives with regard to any given artifact.

#### (b) Experimental arrangement and the subject- object boundary.

As we have seen in the probe illustration, the contrast between analysis and application is correlated with a contrast of mutually exclusive experimental arrangements . Particularly in his debate with Einstein concerning Heisenberg's "uncertainty principle", Bohr stressed this empirical grounding of the two alternatives in order to avoid charges of subjectivism.<sup>9</sup> He argued that the experimental apparatus could not be used to investigate an atomic object and itself be the object of investigation at the same time. The investigation of the experimental apparatus itself would require a change in the experimental arrangement<sup>10</sup>.

Another way of putting this can be developed from the idea of tools as an extension of the observing subject. When the tool is being used or applied, the subject- object boundary is located at the far end of the tool, between the tool and the object beyond. But when the tool is analysed as an object of investigation, then it no longer functions as a tool, and the subject- object boundary is shifted inward to the near end of the tool, between the

tool and the observing subject<sup>11</sup>. The two possible locations of the "subject-object boundary" are empirically grounded (as in the case of the probe), and they are mutually exclusive.

(c) Complementary Modes.

Corresponding to the two models of knowing (analysis and application) and the two possible locations of the subject-object boundary are two "complementary" modes of being in the object<sup>12</sup>. In the trivial case of the stick-probe, these are the modes of "stick" (or stick-probe analysed as a stick) and "probe" (or stick-probe applied as a probe), respectively. A more serious result arises when Bohr applies these considerations to the problem of the stability of atoms. Analysed in terms of space-time locations, the atom is an assemblage of free subatomic "particles", but when the conservation of momentum and energy is allowed to function the atom behaves like a super-position of standing waves and the characteristic properties of a stable atom appear.<sup>13</sup> The two modes of subatomic "particles" and "wave" (or stable atom) are "complementary" and correspond to mutually exclusive experimental arrangements.

(d) Structure and function

The principle of complementarity can be expressed in terms of the more familiar relation between structure and function. The structure of a tool is manifest when it is analysed or examined as an object of investigation. Similarly, the space-time structure of an atom is defined when the latter is analysed into its constituent particles. Conversely, the functioning of a tool and the conservation of momentum and energy require the more holistic "application" approach.<sup>14</sup> In Bohr's terms, function and structure are "complementary" and correspond to mutually exclusive modes of being and modes of knowledge.

(e) Further applications

As he went along Bohr began to find complementarity almost everywhere, but his principal applications beyond the field of atomic physics were to the irreducibility of life processes to physics and chemistry (organismic function complementarity to



molecular structure),<sup>15</sup> the defense of free will and the irreducibility of mental processes to physiology,<sup>16</sup> and the paradox of human freedom and divine providence.<sup>17</sup> Needless to say, these extensions of the principle have been criticised by many of Bohr's colleagues,<sup>18</sup> but they are highly revealing in regard to the overall purpose of Bohr's thought. As Gerald Holton has noted he intended complementarity as a general principle of knowledge with universal significance.<sup>19</sup>

### Polanyi's epistemology

#### (a) Specifiable and tacit knowledge.

Polanyi's terminology is somewhat variable, and he makes some fine distinctions. Generally, he uses the terms "specifiable" and "tacit" (corresponding roughly to "focal" and "subsidiary" awareness) to designate the two modes of knowledge illustrated in the example of the probe.<sup>20</sup> The probe and the impulses it transmits to the hand are "specifiably" known when the subject concentrates on them specifically, but, when he focuses his attention on the far end of the probe in order to acquire specifiable knowledge of the environment, the probe itself and the impulses are known only "tacitly".<sup>21</sup> Tacit and specifiable knowledge may readily be correlated with Bohr's concepts of application and analysis with the one important qualification that the latter refer to the treatment of the probe by the subject whereas Polanyi's terms apply more to the impressions made by the probe on the subject.

#### (b) Mental attitude and the subjecthood of the observer.

As we have noticed, for Polanyi, the transitions between tacit and specifiable knowledge are controlled by the mental attitude of the observer. There is no necessity for a change in the experimental arrangement as there is with Bohr. Corresponding to Bohr's notion of a movable subject object boundary, however, is Polanyi's view of the extensible subjecthood of the observer. As in the example of the probe, any tool becomes an extension of the observing subject when it is "relied upon" for a purpose and is known tacitly like a part of one's body. The subject "pours himself out" into the tool and thus assimilates or "interiorizes" it as part of his own existence; he literally

"indwells" the tool, to use one of Polanyi's favourite expressions.<sup>22</sup>

(c) The parts and the whole.

In the probe illustration, the subject "integrates" the diverse impulses transmitted by the stick in order to perceive the environment beyond. In numerous similar examples, Polanyi associates specifiable knowledge of an object with the "analysis" of its constituent parts and tacit knowledge with the "integration" of the parts into a whole.<sup>23</sup> Hence, as with Bohr, there are two alternative "modes of being" in the object corresponding to the two modes of knowing.<sup>24</sup>

(d) Features and meaning or purpose.

By this integrating the various sense-impressions into a whole, the observing subject discovers their "meaning" in terms of information about the external world.<sup>25</sup> Another example Polanyi frequently uses is the tacit knowledge of a language (vocabulary, grammar) involved in the actual interpretation of a text.<sup>26</sup> Polanyi relates a curious incident in which he had just finished reading a letter yet could not recall in which language it was written.<sup>27</sup>

In a similar manner Polanyi applies the principle of tacit knowledge to the perception of ends or purposes.<sup>28</sup> There is a rough parallel here to Bohr's complementarity of structure and function.

(e) Other applications

Finally we may note that, like Bohr, Polanyi extends his principle of tacit knowledge to the defense of the irreducibility of "life's structure"<sup>29</sup>, the perception of mind and personality,<sup>30</sup> and the religious experience of worship.<sup>31</sup> The overall architectonic of his thought, then, resembles that of Niels Bohr.

This resemblance is all the more remarkable when viewed against the background of twentieth century thought. The contrast of "analysis" and "application" or "specifiable" and "tacit" knowledge has parallels in the thought of Dilthey, Collingwood, and others. What makes the Bohr-Polanyi paradigm distinctive is the fact that the contrast is found within the individual sciences rather than between two opposing camps like the natural and historical sciences (Collingwood) or the sciences and the humanities (Dilthey).<sup>32</sup> As a result, the Bohr - Polanyi approach loosely unifies the sciences into a "system" or "hierarchy" extending from the natural sciences to the humanities.<sup>33</sup>

### Concluding Remarks

In stressing the parallels between Bohr's principle of "complementarity" and Polanyi's concept of "tacit knowledge" I have inevitably overlooked many of the differences between the two authors<sup>34</sup> and have not done full justice to either one. However, in view of the undisputed originality of the two thinkers and the current interest in them individually, it seems imperative to me that they be studied in relation to each other.

One could, of course, look for trends of thought like phenomenology that may have influenced the two men in similar ways. However, the ambiguities encountered in tracing Bohr's intellectual heritage<sup>35</sup> and Polanyi's own criticisms of the phenomenological school<sup>36</sup> make it difficult to account for the parallels simply on the basis of a common background.

More to the point is the fact that both men had wide-ranging interests and were concerned with similar problems. Both were concerned with the problem of reductionism in biology and psychology as we have seen. Both were also open to the possibility of religious experience. Most of all, both were concerned with achieving a conception of reality that is comprehensive, consistent and true to life in all its complexity. The fact that their mature conceptions bear even a "family resemblance" makes them all the

more interesting, in my view, and suggests that they should be taken seriously by those who share their concerns.

Christopher B. Kaiser

### References

1. Three collective volumes of Bohr's philosophical essays have been published: Atomic Theory and the Description of Nature (London:Cambridge University Press,1934) , Atomic Physics and Human Knowledge (New York:Wiley,1958), and Essays 1958-1962 on Atomic Physics and Human Knowledge (New York: Wiley-Interscience,1963).
2. See particularly P.K.Feyerabend, "On a Recent Critique of Complementarity I," Philosophy of Science, XXXV (1968), 309-331, C.A.Hooker, "The Nature of Quantum Mechanical Reality: Einstein versus Bohr", Paradigms and Paradoxes:The Philosophical Challenge of the Quantum Domain, ed. R.G.Colodny (Pittsburgh: University of Pittsburgh Press,1972), pp.67-302, and E.Scheibe, The Logical Analysis of Quantum Mechanics, trans. J.B. Sykes (Oxford: Pergamon Press, 1973),ch.1.
3. To cite but two examples: Karl Popper finds Bohr's complementarity principle "vague and difficult to discuss" (The Logic of Scientific Discovery, New York, Harper and Row, 1968,p.454.), and Einstein complained that he was unable to achieve a "sharp formulation" despite "much effort" on his part (P.A.Schilpp, ed., Albert Einstein: Library of Living Philosophers, 1949,p.674).
4. Principal works are; Personal Knowledge: Towards a Post Critieal Philosophy , Chicago, 1958. The Tacit Dimension, New York, 1966, and knowing and Being, ed. M.Grene, Chicago,1969.
5. Bohr used this illustration only once in his writings (Atomic Theory . p.99), but his associates relate that he frequently referred to it in conversation. See S.Rozental, ed. , Niels Bohr: His Life and Work as Seen by his Friends and Colleagues , Amsterdam, 1967,pp93,306.

6. See Personal Knowledge, pp.55f, Tacit Dimension, pp.12f, Knowing and Being, pp.127f,145.
7. e.g. , Atomic Theory, pp.20,24,96, Atomic Physics, pp.27,52.
8. "Light and Life", Nature, CXXXI (1933),423, Essays, p.5.
9. See "Can Quantum-Mechanical Description of Physical Reality be Considered Complete ?" Physical Review, XLVIII (1935), 696-702, and "Discussion with Einstein on Epistemological Problems in Atomic Physics", P.A.Schilpp,ed.,op.cit., pp.199-241 (reprinted in Atomic Physics,pp.32-66).
10. Atomic Physics, pp.40,72,90,99.
11. Atomic Theory , p.54, Atomic Physics, pp50ff,78ff,91f.Cf. A.Petersen, "The Philosophy of Niels Bohr", Bulletin of the Atomic Scientists, XIX,No. 9 (1963),11.
12. Bohr's first use of the term " complementarity" is in "The Quantum Postulate and the Recent Development of Atomic Theory", Nature, CXXI(1928), 580(cf. Atomic Theory ,pp.54f). For a detailed analysis of Bohr's use of the term see K. Schabe , op. cit., pp.30-35.
13. Atomic Theory,pp.23,77ff, Atomic Physics, pp.6f, 19,21,99, Essays,pp.5,11,63.
14. The relation between structure and function comes out more clearly in reference to the problem of method in biology. See Essays,p.26. Cf. L.Rosenfeld,"Foundations of Quantum Theory and Complementarity,"Nature, CXC(1961),387f, and A.Meyer-Abich, "The Principle of Complementarity in Biology", Acta biotheoretica,XI(1955),62.
15. e.g., Atomic Physics,pp.3-12,13-22,94-101, and Essays.pp.23-29.
16. e.g., Atomic Theory,pp.92-101, Atomic Physics,pp.67-82, Essays,pp.8-16.

17. See John Baillie's account of Bohr's 1949 Gifford Lectures (unpublished) in The Sense of the Presence of God (O.U.P., 1962) p.217.
18. E.g., P.Frank, Modern Science and Its Philosophy (Cambridge, Mass., 1949), pp.166-170, and A.Grunbaum, "Complementarity in Quantum Physics and Its Philosophical Generalization", Journal of Philosophy, LIV(1957), 725ff.
19. G.J.Holton, "The Roots of Complementarity", Daedalus, IC (1970) 1045. Cf. N.Bohr, Essays. pp.7,60,77f,20.
20. E.g., Personal Knowledge pp.55f, Tacit Dimension, pp.9f, Knowing and Being, pp.128,140-144. Strictly speaking tacit knowledge involves both "subsidiary awareness" of the probe and "focal awareness" of the environment, while "specifiable knowledge" involves only "focal awareness" of the probe and the impulses it transmits.
21. Personal Knowledge, p.56, Knowing and Being, p.128.
22. Personal Knowledge, p.59, Tacit Dimension, pp.16f, Knowing and Being, pp.127f,146ff.
23. Personal Knowledge, pp.57., 327,391, Tacit Dimension, pp6,13, Knowing and Being, pp.123ff.
24. In fact, Polanyi refers to the contrasting processes of analysis and integration as being complementary, although he does not cite Bohr's principle in this context. See Knowing and Being, pp.125,129f.
25. Tacit Dimension, pp.12f, Knowing and Being, pp.127f
26. Personal Knowledge, pp57,61,91f, Knowing and Being, p.145. P.A.Heelen has extended the principle of complementarity to deal with the problem of meaning in, "Towards a Hermeneutic of Natural Science", Main Currents in Modern Thought, XXVIII(1972)

85-93, and "Nature and Its Transformations", Theological Studies, XXXIII(1972), 492, 495.

27. Personal Knowledge, p. 57.
28. Ibid., pp. 57, 60f, Tacit Dimension, p. 13.
29. Knowing and Being, pp. 225-239.
30. Ibid., pp. 211-224.
31. Personal Knowledge, pp. 197ff.
32. Polanyi stresses this point in his criticism of the "phenomenologists". See Tacit Dimension, pp. 16f, Knowing and Being, pp. 155f, 160, 221f.
33. Polanyi discusses a possible hierarchical arrangement in Personal Knowledge, pp. 387ff, Tacit Dimension, pp. 37, 41, Knowing and Being, p. 155. The hierarchical implications of Bohr's complementarity principle are developed to some extent by L. Rosenfeld, loc. cit., pp. 387f, and A. Meyer-Abich, loc. cit. pp. 66ff. Cf. L. von Bertalanffy's General System Theory London, 1971, ch. 3, for the concepts of "hierarchy" and "complementarity" in "system theory".
34. Note particularly the difference in their approaches to statistical mechanics. See Personal Knowledge, p. 393, n. 1.
35. See M. Jammer, The Conceptual Development of Quantum Mechanics, New York, 1966, pp. 166-180. and G. J. Holton, loc. cit., pp. 1015-10155. (reprinted in Holton's Thematic Origins of Scientific Thought: Kepler to Einstein, Cambridge, Mass., 1973.
36. See note 32 above.

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