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THE POLANYI – WIGNER DIALOG ON TACIT KNOWING[1]

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ABSTRACT

The article focuses on the ten year Wigner-Polanyi correspondence on epistemology and analyzes their debate. Michael Polanyi was Eugene Wigner's mentor in the 1920s in his laboratory in the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry in Germany. He advised a small group of young expatriate Hungarian scientists, and wrote joint articles with some, Wigner amongst them. Polanyi thought of the group at the Institute as an ideal scientific community – sharing knowledge, skills, and interests outside science – humanities in general, epistemology in particular. Polanyi was convinced that explicit descriptions and definitions do not capture one's knowledge of phenomena, that the foundation of all knowledge is tacit knowing. He explored this by investigating the process of scientific discovery. For him, epistemology had a wide meaning: a combination of informal logic, psychology and background knowledge. Wigner's notion of epistemology was tied closer to the question 'how do we know A is real' a more pressing question for physics than Polanyi's notion. The ten-year correspondence between them explored their understanding of epistemology. Wigner was looking for something he could use to solve the measurement problem in Quantum Mechanics, and he was willing to look to the future for a 'new science' for an explanation, a combination of quantum physics and psychology. Polanyi thought he has found a way to explain tacit knowledge by way of analogy with art. This did not satisfy Wigner as a solution to his problem, so the dialog was inconclusive. The correspondence points to further possibilities to explore the epistemology of science.

Keywords: epistemology, tacit knowing, scientific discovery, Polanyi, Wigner, measurement problem.

1. Introduction

Eugene Wigner was on a search for a new science to solve the measurement problem – something between physics and psychology. In his 1959 paper, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences," Wigner expressed his debt to Michael Polanyi saying that many years ago Polanyi deeply influenced his thinking on problems of epistemology. (Wigner 1967:237)

[1] A version of this paper, with emphasis on Wigner, appeared in *Physics in Perspective* 13(2011): 329-58. Published by Springer. Permission to use parts of it has been obtained by *Polanyiana*.

Not only did Polanyi mentor young physical chemists as a laboratory director and instill in them openness to inquiry, with his philosophical bent he investigated the phenomena of invention and discovery which he knew so well. In this essay Wigner mused: "…it is not at all natural that 'laws of nature' exist, much less that man is able to discover them." (Wigner 1967:227)

By 1959 Polanyi published several papers and two books on his new epistemology, "personal knowledge," knowledge with a knowing subject which is still objective. (It is on a contimuum from personal to objective, the knower's personal participation makes it objective.) As their correspondence shows, this new epistemology gave Wigner hope that the paradox of the "measurement problem" of quantum physics (that the observation changes what is observed) could be solved. As Wigner noted at the end of the above mentioned paper, if no coherent theory of the phenomenon of consciousness would be formulated similar to extant coherent theories of the physical world, scientists' faith in the reality of their concepts would be strained. (Wigner 1967:236) Or as Fritz Rohrlich expressed this, playing on Wigner's title, in the "Unreasonable Effectiveness of Physical Intuition: Success While Ignoring Objections:

> [T]he problems that were ignored turned out to be considerably more difficult than the problems that were actually solved; typically, their solution required a much deeper level of theory than the level on which progress was made. […] One wonders whether the measurement problem of Quantum Mechanics is of this nature. Seventy years of effort… ha[s] not resulted in a definite solution. (Rohrlich 1996:1625)

The search has been on for some time for a coherent theory, a famous version of which was John von Neumann's logical theory of automata paper read in 1948 at the Hixon symposium at the California Institute of Technology. (von Neumann 1951) Wigner referred to it in his Festschrift paper for Polanyi, "The probability of the existence of a self-reproducing unit." (Festschrift 1961) Von Neumann's proposal of self-replicating machines was based on the Turing model, but von Neumann understood that his model does not apply to living systems. Wigner pointed out that his own speculative model differs from this.[2] He said, the present laws of physics do not incorporate the influence of consciousness on matter, and the present concepts of the laws of nature do not include the mutual influence of living matter and consciousness. He suggested that the influence of consciousness on matter is analogous to the direct influence of light on matter as described in the Compton effect. (Ibid. 232)

Wigner's speculative analogy assumes that "the 'living state' is completely given

[2] Von Neumann's model in The Hixon Symposium paper assumes a discreet set of states, while in Wigner's all variables are continuous, and he also assumes that the model is not realistic and does not allow a final state. (Festschrift 1961:236)

in the quantum mechanical sense" and a calculation can be carried out to support this argument. (Ibid. 233) However, the organism is not completely determined in this sense, as there are many states representing a living organism.

2. The Polanyi – Wigner dialog concerning the mind-body problem.

This was a topic of disagreement never resolved between Polanyi and Wigner. The discussion started after Wigner's contribution "Self-reproducing unit" to Polanyi's *Festschrift*. In his letter of April 3 1961 Polanyi states emphatically, that Wigner's position amounts to reductionism, and that no reduction of mental to physical is possible. Polanyi's analogy is a machine as defined by its function, not its parts.[3] But this is only a partial analogy illustrating a hierarchy of levels – and as it turned out, a misleading analogy suggesting insentience as far as Wigner was concerned – machines are constructed for a purpose, while the purpose of living things is intrinsic to themselves. They both agreed that an explanation of living things as machines completely defined by their physico-chemical properties is false. Explaining living organisms by the properties of 'communication,' is also false. Polanyi said in this letter:

> A set of objects may be said to carry the same message if each member of the set has the same meaning. Communications work by embodying their own peculiar operational principles; no physical-chemical analysis of an object conveying a communication will reveal its meaning. In fact, no object has a meaning. It can mean something only to a person who means something by it.

Polanyi goes on to say in this letter, that if Wigner would test his hypothesis, he would find that his claim that his hypothesis is set in opposition to von Neumann's is misleading.

> For, if I am right [Polanyi said] in the interpretation of your argument, it should exclude the possibility of machines or communications being formed according to laws of quantum mechanics from inanimate matter not already embodying communications or operational principles of machines.

Polanyi admitted that Wigner's mathematical proof in the article was "over his head," and that he was only arguing about the reasonableness of the hypothesis. – Wigner in his reply a week later explained that the mathematical proof of his speculative model

[3] Eugene P. Wigner Papers, Special Collections, Princeton University Library. Box 66, Folder 1 (66:1). Hereafter EW Papers (box # : folder #).

claims that it is infinitely unlikely that there are systems which are self-reproducing. This is a statement similar to statements used in thermodynamics, where we always assume that it is infinitely unlikely…[4] In the present case the infinitely unlikely relates to results of the calculations which cannot be carried out in practice. (EW Papers 66:1)

Wigner believed von Neumann was firmly convinced of this conclusion with regard to living beings, i.e. the unlikelihood that self-reproducing units of the type of living beings could arise, even though he did not publish his thought on this. (EW Papers 66:1)[5]

In the same year in 1961, Wigner took another tack at the problem of how to deal with the quantum mechanical theory of observation, but this time from the angle of the concept of the real. In his article "Two kinds of reality" he offered a dualist position. (Wigner 1967) The first kind of reality is consciousness, an obvious fact which is often disregarded when focusing on the content of consciousness (i.e. on everything other than one's consciousness), and the content of consciousness is the second kind of reality. Normally one is not aware of the operations of the mind, except in the process of learning something.[6] Wigner considered this first reality absolute, or possibly considering the absolute a limiting case of consciousness. He also called it "personal reality". The second reality – that of objects – is sharply divided from the first, and is of various degrees of probability, although we accept them as "real" for our picture of the world. Wigner considered the consciousness of others as well as (spiritual) values to be the same degree and type of reality as that of objects. This, he states, "is the only known point of view which is consistent with quantum mechanics." This second type of reality is the universal or impersonal one, and the concept cannot be made meaningful without accounting for the phenomenon of mind and integrating it into our understanding of physical phenomena. (Wigner 1967)[7]

The two kinds of reality, consciousness and its content, are related in such a way that not only is absolute reality not independent of the constructs of the universal reality, but contrary to naïve beliefs, both share the property of impermanence.

[4] I.e. "it is infinitely unlikely that the system occupy one of the periodic orbits if there is only a finite number of such orbits." (11th April 1961, EW Papers 66:1)

[5] von Neumann's last speculations on natural and artificial memory were written for the Yale Silliman Lectures published posthumously as *The Computer and the Brain* (Yale University Press 1958)

[6] Wigner's favored source of explanation of conscious and unconscious processes is J. Hadamard's clear but general description of mathematical invention, according to which the unconscious is a manifold (it can combine and synthesize ideas). There is a range of consciousness from fringe-consciousness, the 'ante-chamber', to full consciousness. Then the mind chooses from the combinations by an "aesthetic sieve", an essential means. In this process, the will of finding a solution is crucial. (Hadamard [1945] 1949, chapters 2 & 3)

[7] In this article Wigner refers (on p. 187, n. 3) to an important 1939 monograph by London & Bauer, *The Theory of Observation*, which says "the measurement is not completed until its results enter our consciousness." (Thanks to Abner Shimony for bringing this reference to my attention.)

Scientific thinking before quantum mechanics considered consciousness to have no influence on scientific explanation. After quantum mechanics explanation should give an account not only of the phenomenon, but its circumstances and related phenomena. (Wigner 1967:193) In terms of the "paradox of measurement", it means that measurement ("reading") cannot be interpreted if the properties of the measuring apparatus are not known or taken into consideration, i.e. correlation between the "'object"' and the measuring apparatus must be taken into account. This has not been done satisfactorily, and will require the study of concept-forming abilities and what we call intelligence (a fully "awake" consciousness – Wigner's example was the mind of von Neumann).

Wigner was puzzling through the "mind-body problem". A traditionally difficult problem he made seemingly even more so by slicing the world into two kinds of reality instead of the notion of continuum from personal to objective as Polanyi has done. (See section 7 below) Wigner's two kinds of reality now need an explanation for their relation.

In his October 6 1961 letter he expressed high interest in Polanyi's (pre-publication) article "Clues to the understanding of Mind and Body", which was stated in the context of Polanyi's theory of tacit knowing. (in Good 1962:71-8; in Grene 1969b: 159-80) In this letter Wigner has shown agreement with Polanyi's conclusion, but was not convinced of his argument. (EW Papers 66:1)

Polanyi's conclusion in this article states that entities are made up of hierarchies of levels of existence, each level relying for its workings on the laws of the level below it, but a more complex higher level's operation cannot be accounted for by laws of lower levels, i.e. in terms of its particulars. (Ibid. 175) The relationship between levels can be described thus: the boundary condition is defined such that the principles of each level operate under the control of the next higher level. The possibility of the extent of explicit description of particulars varies with levels, and their connection that forms the comprehensive entity varies with systems (objects, living entities, skills such as skillful knowing-and-doing, and responsible judgment). – Thus, Polanyi's conception of reality is hierarchical, where more complex entities seem to be "more real", i.e. the mind is more real than a stone.

Polanyi's argument to support this claim is rather involved, but the general idea is that the higher the level, the more difficult it is to state explicitly and fully all the connections of the particulars which make the entity function as a whole. (The entity's description is underdetermined). He goes further, to state that one could not identify particulars except by previously attending to the entity as a whole. Specifically, workings of the mind cannot be explained by particular behaviors, or by equating the mind with its workings. The workings of the mind and the observations it makes cannot be focused on at the same time. (The foci are mutually exclusive – one cannot pay attention to the object of the action and the action at the same time.)

To explain his partial analogy of machine-like hierarchical levels, he noted that machines and living systems are alike in that in both the system is unspecifiable

in its particulars. (Polanyi [1958] 1962, Ch. 13, esp. 401) He remarked that if causal explanation is sought, one must say with regard to machines that initial conditions (controlled by the laws of technology which cannot be accounted for by the laws of physics and chemistry) must be taken into account before one can rely on the machine's operation to make predictions. (in Good 1962:75) By analogy, (taking the living body as a "machine") the parameters of the living body are left just as undetermined [sic] by physics and chemistry as that of the machine. Consciousness must be recognized as acting as a "first cause" for the machine – human intelligence created the machine. The emergence of higher levels is an innovation initiated by a "first cause".[8] For the sake of continuity, and by analogy, one would have to postulate a sentient first cause of organic evolution. (in Good 1962:77)

Speculation on how living beings evolved from inanimate matter has not been lacking. Mechanistic conception of the universe would lead one either to hypothesize that entities were "preformed" by suitable patterns of parameters, in which case there would be nothing new, and the notion of randomness would have to be abandoned – or, human beings would have to be represented as insentient automata.[9] A clue has been offered by living organisms, by the process of repair and adjustment in embryonic development and beyond. Gestalt psychologists likened these primitive integrations to the ability of animals to reorganize their field of experience, and the ability of people to innovate (a faster process than evolutionary changes). However, the scope of causes at the highest level are restricted by time and place, and directed toward the possibilities of innovations. For this idea Polanyi was accused of "entelechy" – but it is simply the teleological process, the "vector".[10]

Polanyi's conception of the relation of epistemology and ontology is somewhat peculiar, and can be misleading for those who are looking for clear delineations. He said:

[8] But see Polanyi ([1958] 1962:384) "The Rise of Man". Where he said: evolution like life itself can be said to have originated by the action of an ordering principle sustained by environmental conditions. The "ordering principle" is not explained well. The schema seems to be parallel to "tacit integration" in his epistemology.

[9] For Polanyi, randomness is an example of emergence to higher ontological levels, in the sense that an increase in randomness increases entropy and increases the possibility for new combinations. Degrees of randomness can happen by occasional fluctuations caused by internal or external forces, a decrease in randomness means the system would "sort itself out" and become more predictable. (Polanyi [1958] 1962:391)

[10] When Polanyi speculated on the evolution of man, he said: "The rise of man includes a continuous intensification of individuality, similar to that which normally takes place in the formation of a human person from a parental zygote. No new creative agent, therefore, need be said to enter an emergent system at consecutive new stages of being. Novel forms of existence take control of the system by a *process* of maturation." (Polanyi [1958] 1962:395) His notion of "'maturation"' in his ontology is analogous to "meaning making" in his epistemology. His epistemology and ontology are isomorphic. See Polanyi (1966:33,55) and see section 9.4 below. Also see Jha (2002, Chapter 9), "Polanyi's problematic architectonic – a critique," esp. p. 225 n. 4.

> Strictly speaking, it is not the *emerged* higher form of being, *but our knowledge* of it that is unspecifiable in terms of its lower level particulars. We cannot speak of emergence, therefore, except in conjunction with corresponding progression from a lower to a higher *conceptual* level. And we realize then that conceptual progression may not always be existential, but that it becomes so by degrees. (Polanyi [1958] 1962:393-94)

That is, Polanyi's ontology is generated out of and is isomorphic with his epistemology. Wigner was not convinced by Polanyi's arguments. He said in this same letter (October 6, 1961. EW Papers 66:1):

> If we had a state of very low entropy, the subsequent increase of entropy may lead through stages of surprising regularities [e.g. the development of the solar system]. I do not believe that the case which you consider is comparable with this example but the fact of surprising regularities remains. [… I] realize that no argument on this question can be 'rigorous'.

2.1. Polanyi's most direct answer to Wigner's puzzle: making sense – "indwelling" and observation

The next substantive exchange between Polanyi and Wigner occurs after Polanyi sent Wigner his 1962 article "Tacit knowing: its bearing on some problems of philosophy," (in Grene 1969b) which was a published version of one of his Yale Terry Lectures. Here Polanyi explored his notion, that all understanding is grounded in tacit knowing and all understanding is achieved by the act of indwelling: "When exercising a skill we literally dwell in innumerable muscular acts which contribute to its purpose, a purpose which constitutes their joint meaning."[11] It is a mistake to distinguish indwelling from observation as practiced in the natural sciences – it is a matter of degree, a continuum: indwelling is less deep when observing an object, than when understanding a work of art or a person. Indwelling bridges the gap between the two by rooting the person in the awareness of his body.

> [W]e are able to make sense of clues or particulars to which we are not attending at the moment, by relying on our awareness of them for attending to something else – so that the appearance of that which we are attending may be said to be the meaning of these clues or particulars. Once we had grasped this way of making sense, we also realized that the position at which the meaning of the clues appeared to be situated did not coincide with the position of the clues themselves and could lie in some cases nearer to, in others further away from them. (Grene 1969b:161)

[11] In one of his notes dated 29/8/1960 on perception he says on 'indwelling': 'invade, move in, occupy, come to reside. Indwelling – moving into residence,' Indwelling is active. (Michael Polanyi Papers, Regenstein Library Special Collections, University of Chicago, Box 22, Folder 3 (22:3). Hereafter MP Papers box # : folder #)

This can be taken as Polanyi's explanation to Wigner's puzzle, and is the most direct reference to Wigner's measurement problem in terms of tacit knowing – it is the observer's act of "making sense".

Studies in neurology, motion studies in skill acquisition, analysis of language, all attempt to understand tacit knowing, in which we attend to something by relying on clues, elements, and particulars we are not attending to at the time. The phenomenon studied may be called "intuitive", which these studies attempt to formalize, to capture fully by specifying the elements and stating the rules of integration into "wholes" explicitly. But since focusing on the elements destroys the meaning of the whole (whether the whole is a piece of art, a physiognomy or a skill) no formalization in this manner is possible – one has to limit oneself in the effort of "specifying" to discovering maxims that can be applied artfully. The original tacit act will largely remain tacit. -- It is an interesting point, that tacit knowing can integrate conflicting clues in various ways (in Grene 1969b:167) and can resolve a contradiction by revealing a joint meaning of these clues in terms of a new quality (e.g. stereo sound).

The theory of phenomenalism teaches one to consider sense data as ultimate information about the outside world,

> and to regard our knowledge of the objects to which sense data refer, as based on inference from these data. This gives rise to the insoluble problem of the manner in which such inference can be carried out. [It seems Polanyi thought this may be Wigner's problem]. The school of linguistic analysis disposed of this problem by affirming that we never perceive sense data as such, but are aware of them only as qualities of objects, which are what we actually do perceive. (Grene 1969b:169-70).

Polanyi adds that we do see sense data until we make an intelligent effort to see the "objects" of which these are the qualities. This intelligent effort is tacit integration by which the object is recognized as the "meaning" of the sense data. It is not an explicit process (such as Wigner's calculations) – trying to make it explicit makes the problem into an insoluble one. In his work the scientist focuses on the meaning of the clues, while he is "groping" towards new ideas and evidence following his hunch.

How does one deal in this context with the problem of how primary qualities give rise to secondary qualities? Primary qualities today mean the parameters of statistical functions as determined by quantum physics. How do these give rise to qualities such as color, sound, etc. by means of configuration of these parameters? "[P]rimary qualities representing the objective reality of all things and secondary qualities deemed to be subjective." (Grene 1969b:173) The puzzle is, how do we answer questions of experience (of color, sound, etc.) which are not directly derivable from the conceptual framework of physics, how do we "explain" things with the "bottom-up" method? The theory of hierarchies of laws would affirm that we cannot,

as Polanyi illustrated it with the example of the machine's levels of structure and function – the operational principles of the machine, the function for a purpose, defines and explains the machine, not its primary qualities. Another illustration was the example of a map: elements of a map are meaningless by themselves – only when the elements are integrated into a whole which we recognize as having the meaning "map" (a figure that functions as a map). The elements were integrated by the process of tacit knowing, "making sense", described above. Polanyi's answer only alluded to the process Wigner attempted to understand in a more specific (scientific?) way.

3. Polanyi's analysis of knowing

The process of knowing is in two stages: subsidiary attention and focal attention. The second relies on the first – when it becomes transparent to us that we are looking at a map of X, i.e. the map is in our focal awareness, it is by relying on the various clues, the elements which are in our subsidiary awareness, and which our tacit knowing integrates, that we are able to understand what we are looking at. The map is defined by the meaning we give it, by its function, not by the lines and their position in space which compose it. This process cannot be dismissed as a purely 'psychological' process. Since the result of the process of integration can be fallible, the process is one of logical inference – a tacit logical inference. It is personal judgment and it is used in scientific inquiry.

Wigner's reaction in his letter of December 17, 1962 to Polanyi's rather thick description of tacit knowing and its various illustrations and analogies was confusion about the details, but agreement with the general idea that there is tacit knowing:

> I am not sure that the distinction you make between tacit knowledge and subconscious knowledge is equally clear. […] There is only one sharp distinction that may exist between the two, […] we can not consciously recall the time of a subconscious thought. [This is the puzzle of the measurement problem in quantum physics Wigner has been struggling with for some time, and for which he looked to Polanyi's notion of tacit knowledge for help. He continues:] Your point of the absurdness of disregarding what you call tacit has often occurred to me. First, actually, when analyzing the epistemology of quantum mechanics. This purports to give probability connections between subsequent observations. However, by observations they mean conscious impressions. If one tries to think this through, one soon realizes the absurdity of the position. How do we know the properties of the apparatus which we use for our 'measurements' (observations)? Evidently, from having observed the apparatus. This preliminary observation tells us whether we have a grating or a microscope at hand. However, this evidently involves us into an endless process and we must, rather admit that we have some knowledge

which developed in our unconscious, as your tacit knowledge, without conscious observations. (MP Papers 6:2)[12]

Wigner may be correct in his complaint about Polanyi's article "Tacit Knowing: its bearing on some problems of philosophy", However, in a previous 1961 article in *Mind*, "Knowing and Being,", Polanyi gave a detailed explanation of tacit knowing as constituted of various levels of consciousness. (Grene 1969b:123) Similarly he did so in the volume *The Scientist Speculates* to which both contributed. (Good 1962)

One more topic Wigner finds lacking in Polanyi's writing, as he said in this letter – a discussions of innate knowledge, inherited knowledge in animal instinct, inherited capabilities, an so on, all of which constitute a much larger part than our learned conscious knowledge. When we speak about ourselves, we speak of this small conscious part, and we speak of it as a possession. – It seems, at this point he has not yet read Polanyi's book *Personal Knowledge*.

There is a two year gap in the correspondence, during which both wrote on related topics: Wigner wrote "Remarks on the mind-body question" (interference of the observer in measurement), "Two kinds of reality" (consciousness and objects) and the "Problem of measurement", (the orthodox view and its critique) – while Polanyi wrote "My time with X-ray crystals" (on discovery), and "The unaccountable elements in science" (on intuitive surmise and informal decision making, "mother-wit" and gestalt perception).[13] All of these papers explore how the mind inter-acts with or understands physical reality. If they were discussing or otherwise following each other's efforts on this topic, we will have to glean this from these essays viewed as a conversation between them. (See section 10)

4. Wigner's 'Polanyian' epistemology.

The correspondence resumes in 1965. During the years 1965-1966 Polanyi came to the USA at least twice, during which time the two met. Polanyi organized a study group on the Unity of Knowledge, which held meetings in the USA during two consecutive summers in Maine.[14] Wigner participated in these meetings with the paper "Epistemology of quantum mechanics – its appraisal and demands" and Polanyi contributed "The structure of consciousness." The correspondence includes

[12] Typed extract from Wigner's letter. No full copy of the original exists in the Wigner Papers.

[13] See References at the end for these articles.

[14] Papers were collected and edited by Marjorie Grene in *The Anatomy of Knowledge: papers presented to the Study Group on Foundations of Cultural Unity, Bowdoin College, 1965-1966*. (see Grene 1969a) Articles of Wigner: pp. 31-46, Polanyi: pp. 318-330. In the Polanyi archives this group is identified as the Unity of Knowledge Group, the name change occurred after the conference. Reprinted in a collection of various essays by the same group a *Toward a Unity of Knowledge*. (Grene 1969a)

two letters from Wigner, with substantive comments on the mind-body problem that continued to trouble him. Prior to the 1965 summer conference, on February 19, 1965 he writes to Polanyi in anticipation of discussing the question in person: he was just reading Polanyi's book *Personal Knowledge*, and wanted to bring up a point of difference between their thinking:

> We both feel that materialism is absurd, and in this we entirely agree. However, your principal reason is based on Gestalt theory. I agree with the very important and interesting points which this theory makes, but my own reason for disagreeing with materialistic philosophy lies on a lower level already. I think it is about as incorrect as to pretend that mechanics gives the answer to all physics and that electric phenomena follow from classical mechanics. I have two reasons for believing this. One is entirely ontological, the other one is based on modern quantum mechanics. This may not give the full picture, but, on the other hand, there is no reason to believe that an earlier and less complete theory does give the full picture. (EW Papers 66:1)[15]

There is no record of Polanyi's reply. One should note however, that although Polanyi's philosophy cannot be categorized as idealist, he does assign "'more reality"' to ideas than to material objects, as mentioned above. Wigner's ontology, as we saw above in "Two kinds of reality", also gives more weight to one's thought as real. Therefore, for both, man is not explained by materialist philosophy. Also, as Wigner said in his 1965 conference paper on the epistemology of Quantum Mechanics, and in a paper "Are we Machines?" (Wigner 1997:483) Quantum Mechanics is not a "materialist" theory. On this last point Polanyi did not agree: as he said "a change from classical mechanics to quantum mechanics makes no difference to the 'mechanistic' outlook." (Polanyi [1958] 1962:390) (See his comment on Wigner's reductionism in section 7.).

Following the conference Wigner writes on 14 Sept. 1965:

> I have been giving a bit of thought to our attitudes toward the question of life and perhaps I do understand a little better what I find not fully satisfactory in your thinking. It seems to me that you make the same difference between living and inanimate objects as between a machine and its constituents. In other words, your emphasis is on the purpose of the machine and also the purposefulness of the arrangement of objects in living beings. I cannot quite believe that this does full justice to life and, even emotionally, I do not feel that it is desirable to equate machines and living beings. From an unemotional point of view I would argue that almost all new sets of phenomena such as electricity, nuclear forces, heat, light, have required either entirely new concepts for their description, or at least a new and striking re-interpretation in terms of phenomena. I do not see

[15] Apparently Wigner did not find Polanyi's comments on the measurement problem on pp. 392-3 of *Personal Knowledge.* See these comments in section 9 below.

> anything like this in the present discussion of life, [...] I feel that the phenomena of desire and emotions are at least as new to present physics as was electricity to Mechanics and that it won't be possible to describe it in the same terms, not only on the low level on which machines can be described adequately. In other words, I consider the difference between life and machines enormously great because the machines do not show the phenomena of volition and emotion. I am sure I grossly misrepresent and probably misunderstand your views. However, I would like to know in which way. (EW Papers 66:1)[16]

It is obvious that Wigner found Polanyi's partial "machine-like" analogy wrong for stratified structures of comprehensive entities, and the term "boundary conditions" borrowed from physics not quite clear. (See section 7 below). He did not see the relationship Polanyi wanted to select for the analogy: the hierarchy of levels of innovation. Wigner did find Polanyi's notion of re-framing and re-conceptualizing to understand new phenomena to his liking. This second aspect was where they found their common ground.

This letter was followed by a planned personal meeting and discussion in Princeton in 1966, of which there are no written records. A two year hiatus follows, Wigner initiating correspondence, followed by sending Polanyi a paper which Polanyi calls "on men and machines" – this seems to be the 1968 paper "A physicist looks at the soul" (Wigner 2001:41) discussing three points of view: a Laplacian purely mechanistic view, the "translation of physical laws" view (translation of laws of physics into recordable evidence), and the "laws of physics as the limiting case" (if life plays no role) view. Wigner subscribes to the third view:

> It is true that matter influences my consciousness, but I believe it is also true that the atoms in my brain do not follow the laws of present-day physics. The next major change in physics will be, I hope, an incorporation of the phenomena of life and consciousness into this discipline. (Wigner 2001, Vol. 7B, 43)

As the years pass, letters are becoming sparser, though Wigner still approaches Polanyi in a letter for discussion and general thoughts on his puzzle as he is struggling with the epistemology of quantum mechanics. (September 20, 1969, MP Papers 7:16) He was re-reading Polanyi's 1959 *The Study of Man*, a concise form of his earlier magnum opus, picking up on

> the points you make about the language and its reliance on tacit knowledge. We speak about measurements in quantum mechanics but we do not tell how we know the properties of the measuring instrument, how we were informed that a particular apparatus is to be used and to what purpose.

[16] For Polanyi's explanations, see "The structure of consciousness."

Polanyi's proposed visit to Princeton to meet Wigner did not materialize. To continue the discussion however, Wigner commented in his letter of 4 February1971 on Polanyi's (pre-publication) paper "Genius in Science" which he received earlier.[17] *(MP Papers 9:7) This paper is a clarifi ed short presentation of Polanyi's book Personal Knowledge* on tacit knowing, this time with the emphasis on scientific creativity as a process of insight driven by the imagination and anticipation based on hunches of a scientist. Scientific creativity, Polanyi insists, is not a process of refutation of earlier theories, nor theory construction from collections of data. What can be observed depends on the theory. Polanyi makes the same analogy between gestalt perception and creative scientific insight as he did in his *Personal Knowledge*, but adds, different branches of science are based on different ways of seeing (i.e. ways of seeing are framed by one's theory). Polanyi's notion of the driving force of imagination and the pull of anticipation is reminiscent of Poincare and Hadamard, as well as Polya, and analogous to Merleau-Ponty's theory of bodily actions. His shorthand explanation for meaning making is "personal judgment", the scientist's participation in and evaluation of his act of the scientific process.

Although Wigner agrees with the overall tacit knowing thesis, he disagrees with the summary on which he focuses in this letter:

> I do not fully agree with what you say... that natural science is an extension of perception. I think you are making this point in relation to gestalts-theories, while I mean it epistemologically. [...] It is very unclear how we have learned [things which we learned in babyhood]. I still do not understand how our children guessed that there is a meaning in the sounds which come out of our mouths and how they ever guessed their significance. (MP Papers 9:7)

It seems Wigner missed Polanyi's point on the passivity of gestalt theory, that this theory is only an initial analogy on which he built a layer of active participation and a layer of meaning-making, also by analogy. The whole structure and function explained in much greater detail in his various books and articles.[18] It could be said that Polanyi's epistemology incorporates psychology. – Wigner mentions that he learned from Hadamard that there are two stages of mathematical invention – intuitive knowledge, followed its formulation (these would correspond in Polanyi's theory to the tacit-explicit aspects, but written in a clearer prose with less complex structure). Wigner's comment is perhaps fair, if "Genius in Science" is taken in isolation, but not if the corpus leading up to it is known, as it was presumably by Wigner. This leaves the possibility, that Wigner understood Polanyi's theory as a

[17] Appeared in *Encounter* 38 (Jan 1973) 43-50. Reprinted in R. T. Allen ed. (1997) Society, *Economics and Philosophy: selected papers of Michael Polanyi*.

[18] For an analysis of Polanyi's schema of tacit knowing with its various layers and their functions, see Jha 2002:51-69, 123-48.

psychological one, and his own search as one for an epistemological explanation. We may note again that the meaning of epistemology for Polanyi was a combination of informal logic, psychology and background knowledge culminating in meaning making, a combination he considered to be a general, broader epistemology. The meaning of epistemology for Wigner, according to the considerations above, would have been meaning-making grounded in quantum phenomena – and yet, as he said in his 1969 paper "The Epistemology of Quantum Mechanics", we see that what he means by epistemology is answering *how do we know,* show, prove what we "know" is "real" (i.e., that in quantum mechanical measurement the state vector *represents* reality).[19] Since observation changes what is observed (it is not continuous over time) and can be represented only by probability laws, the problem becomes for him the double one of epistemology and ontology. He is not willing to accept as a solution the explanation that the state vector is only a tool for calculating the probabilities, only a tool for predictions. He would also not agree that classical physics (macrophysics) and quantum physics are discontinuous – both follow causal laws. He would most likely not accept the following repair of the standard Copenhagen view.[20]

5. Criticism and defense of Wigner's "Polanyian" epistemology

5.1. Criticism

In "On the quantum theory of measurement" Feyerabend suggests that the theory of measurement under discussion is incomplete, and a theory can be developed

> [w]hich depends, just as its classical counterpart does, on nothing but equations of motion and the special conditions (macroscopically distinguishable states; macro-observers) under which those equations are applied. [...] [Then it could be shown, that this has the consequence (a) that] there are no quantum-jumps and (b) that the idea that there are quantum-jumps has its origin in an incomplete theory of measurement. [...] What is omitted is the fact that M [measuring apparatus] is a macroscopic system and that B [pointer] cannot discern the finer properties of M. [...] Now the transition from the level of QM to the level of classical mechanics involves certain approximations. Within a theory of measurement which omits reference to the macroscopic character of both M and B those approximations cannot be justified. Hence, within such an incomplete theory the transition to the classical level will have to be treated as an

[19] "However, it is dangerous to attribute physical reality to this vector, first, because it is not quite clear what physical reality means, and second, because it changes as a result of observation in a way not given by its equations of motion [collapse of the wave function]." (Grene 1969a:31-45; reprinted in Wigner 2001 6B p. 49-53).

[20] See his critique in "The problem of measurement" in *Symmetries and Reflections* (1967:153-170, as noted in section 3 above).

> independent element which cannot be further analysed and which cannot be explained in terms of the equation of motion. We suggest that a complete theory which contains a reference to the macroscopic character of both B and M will allow for such an explanation." (Feyerabend 1981:213-6)[21]

He also noted, that observation can be made without an observer (by a camera), to simplify the argument.

Putnam, addressing both physicists and philosophers discussing the issues, expressed the opinion that there is something wrong with the conventional theory. (Putnam [1975] 1979:81)[22] Superposition, something being in a state both A and B at the same time, a particle behaving as if it is going through both slit 1 and 2 at the same time, is called the measurement paradox. But conditions in the macro-world are different – in the macro world, a cat being both alive and dead at the same time does not happen, the conditions cannot be super-imposed. Therefore, Putnam says, these assumptions of conventional quantum mechanics constitute a contradiction. [See his definition of state vector on p. 80 ibid.] He notes, that Wigner and Margenau defend the adequacy of the received view (of quantum-jumps/collapse of the state vector) along a somewhat different line:

> According to them quantum mechanics presupposes a cut between the observer and the object. Any system can be taken as the object; however the observer himself cannot be included. […] The observer always treats himself as possessing definite states which are known to him. Here Margenau and Wigner deviate slightly from the Copenhagen Interpretation. According to Bohr and Heisenberg, the observer must treat himself as a *classical* object, i.e. everything on the observer side of the 'cut' (including the measuring apparatus) is treated as obeying the laws of *classical* physics. Margenau and Wigner do not mention this. What they rather say is that the observer must include 'consciousness'. Thus they deviate from the Copenhagen Interpretation in a *subjectivistic* direction. Whereas the fact that we do not get superposition on the observer side of the 'cut' is explained on the Bohr-Heisenberg story by the fact that we use *classical* physics on this side, it is explained on the Margenau-Wigner story by the fact that we have a faculty of 'introspection' (cf. London and Bauer (1939) for the source of this interpretation) which enables us to perform 'reduction of the wave packet' upon ourselves. (Putnam [1975] 1979:81)

[21] Wigner disagrees: "at present there is no clear evidence that quantum mechanics is valid only in the limiting case of microscopic systems, whereas the view here represented assumes it to be valid for all inanimate objects." ("Remarks on the Mind-Body question." In Good 1962:300, fn. 11)

[22] In "Philosophy of Physics – the problem of 'measurement' in quantum mechanics." First published in Franklin H. Donnell Jr. (ed.) *Aspects of contemporary American Philosophy* (1965), Wurzburg, Physica-Verlag, Rudolf Liebing K. G. Reprinted in Hilary Putnam 1979.

5.2. Defense

To these charges Wigner and Margenau respond, that Putnam challenges them to restate the theory without mathematical formalism and that Putnam's argument is faulty:

> According to von Neumann and London & Bauer every measurement is an interaction between an object and an observer. [...] The object obeys the laws of motion, [...] as long as it is ...separated from the rest of the world. [...] this is the case during time intervals *between* measurements. [...] [and not true during measurement] [...] The chain of transmission of information from the object to the consciousness of the observer may consist of several steps... . One cannot follow the transmission of information to the very end, i.e., into the consciousness of the observer, because present-day physics is not applicable to the consciousness [of the observer] [...] [as] has been clearly recognized by both John von Neumann and by London & Bauer. As they express it, one must introduce a cut between object and observer and assume that the observer has a 'direct knowledge' of what is on his side of the cut. [...] We must also reject the suggestion that quantum mechanics treats the universe as consisting of two qualitatively different kinds of things, "classical" objects and micro-objects. [...] [C]lassical objects are included as proper limiting concerns of a probabilistic theory which, in this limit, reduces to classical physics. (Margenau and Wigner 1962:292-3)[23]

6. Wigner's attempt to clarify "Polanyian" tacit knowledge

Although Wigner satisfied himself that his explanation to Putnam will stand, he was still looking for an epistemological explanation to reconcile or integrate the incompatible elements in tacit knowledge. Polanyi sent him his lecture on "Visionary Art" which contained his views on the integration of incompatibles.[24] By this time the two were "talking past each other", and Wigner was polite and respectful about Polanyi's "helpful" analogies. In the postscript of the above mentioned letter of February 4, 1971 Wigner said: "I enjoyed many parts of it, but do not feel its meaning. Perhaps, as I often say, wisdom cannot be taught except to those who already possess it 'tacitly'." (MP Papers 9:7)

[23] Margenau and Wigner, "Comments on Professor Putnam's Comments." In *Philosophy of Science* 29 (1962) 292-93. Reprinted in Wigner (1995) pp. 31-2. For Putnam's reply see "'Discussion: Comments on Comments on Comments: a reply to Margenau and Wigner." *Philosophy of Science* 31:1-4. (1964) Reprinted in *Philosophical Papers* Vol. 1, pp. 159-65. For Polanyi's notion on direct and indirect knowledge, see end of section 7 below.)

[24] The Meaning Project, University of Chicago Lecture 3, "Visionary Art," May 27, 1969. MP Papers 39:10)

Apparently Polanyi sent the manuscript of this 1969 lecture to Wigner as part of their conversation on Wigner's puzzle about the measurement problem that observation changes the observed.[25] The lecture is an illustration of the way the mind integrates incompatible elements and interprets them in a [new] coherent framework. Polanyi thought this is also done in the natural sciences:

> The creation of hitherto inconceivable conceptions by the combination of hitherto incompatible features is a commonplace in mathematics and modern physics and, here too, these innovations are usually fraught with indeterminate implications. (Ibid. 23)[26]

The detailed illustrations explaining the mental process are from surrealist painting, poetry of Baudelaire, Rimbaud, Eliot, etc. (he called these poems of symbolism, intuitionism and formalism by the collective term 'visionary art'), as well as from the structure of myth as analyzed by Eliade. The artist's interpretation of experience must make a break from our usual perception – it views it subject suspended in one moment, timeless. The form and content of the poem or the painting are deliberately incompatible; the acceptance of such art by the viewer is done

> by sustaining the belief that art is meaningful, and discovering thereby the joint meaning of its focally incompatible elements. (Ibid. 3) [He goes on to say:] [T]he powerful act of the imagination …comprehends all details in one… its disparate elements have a joint meaning, […] which will be strikingly novel…the more incompatible were its unintegrated elements. (Ibid. 7) […] [W]e find their visionary form unintelligible until we realize that we must not try to understand them as representing a sequence of events that hang together in the way real events do. […] [and quoting Robbe-Griller he continues:] 'In the modern novel time has ceased to exist. Or rather it is a time without temporality, it is an instantaneous time which never creates a past […] never accumulating to form either a memory or things past to which one can refer one day; it is a present that has no value save in the present. (Ibid. 9)

Polanyi means by this, that this non-temporal instant (in myth it is the "beginning of time") is to be differentiated from normally perceived time, which is perceived as continuous and irreversible. (Ibid. 9)

> Art creates facts of our imagination, which guide our thoughts. The artificiality of form enables it "to act as a framework detaching the events to which they apply, and endow these with tangible and lasting quality by luminous imaginative powers [insight]. (Ibid. 15)

[25] Observation in two senses: the act of observation and the data.
[26] "Visionary Art" Ibid. 23.

Although Polanyi thought that his exploration in this lecture – of how incompatible elements can be given meaning by a new framework – would be a key piece in the epistemology of quantum measurement Wigner was looking for, Wigner's comment to him was, that he did not understand Polanyi's meaning, that perhaps "wisdom cannot be taught except to those who already possess it 'tacitly'." Wigner seemed to be frustrated by Polanyi's examples and analogies – they seemed too vague and mystical, and did not capture what Wigner was looking for. Perhaps the meaning of "incompatible" was so different for the two, that they could not envision "integration in tacit knowing" in the same way. Was Polanyi saying, the incompatible elements (behavior as either particle when observed, or wave when not observed) can be integrated somehow by the power of the imagination, but then does not say how? Was he saying one needs to believe that science is meaningful, that the scientist's interpretation of the event is not like interpretation of ordinary events? But earlier Polanyi used the analogy that scientific understanding, insight, is similar to gestalt perception, an analogy Wigner objected to, because he was looking for an epistemological explanation, and took Polanyi's analogy as a psychological one. Was his comment about 'tacit wisdom' a way of saying to his aging teacher and friend "you are not explaining, you are retreating into poetic descriptions which do not apply"?[27]

7. Polanyi's "definitions" of aspects of tacit knowing

Although both Polanyi and Wigner refined their working definitions of epistemology, it would be useful to see how these were related over the ten-year period when they were corresponding about this topic.

First, Polanyi's view on how he sees the relation between epistemology and psychology, since this was one of the aspects Wigner found frustrating in Polanyi's explanations.

He said on knowledge interpreted from behavior:

> Epistemology reflects on knowledge which we ourselves believe we possess; the psychologist studies knowledge which he believes to have been acquired by another individual and studies also the shortcomings of such knowledge. No knowledge, whether our own or that of a rat, is fully specifiable; but the fact that we must rely on recognizing the rat's knowledge, or ignorance, from our knowledge of the rat's behaviour, involves an additional enquiry and an additional unspecifiability. (Polanyi [1958] 1962:365)

[27] Wigner was famous for his courtesy. After this exchange there is one more letter the following month about an upcoming conference, but no discussion. Correspondence continues sporadically until 1974, but there are no further substantive exchanges on epistemology.

In *Personal Knowledge* Polanyi "defined" his new epistemology this way:

> I start by rejecting the ideal of scientific detachment. ...[I]t falsifies our whole outlook far beyond the domain of science. I want to establish an alternative ideal of knowledge, quite generally... Personal Knowledge. The two words may seem to contradict each other ... But the seeming contradiction is resolved by modifying the conception of knowing. [...] I regard knowing as an active comprehension of the things known, an action that requires skill. Skilful knowing as doing is performed by subordinating a set of particulars, as clues or tools, to the shaping of a skilful achievement, whether practical or theoretical. We may then be said to become 'subsidiarily aware' of these particulars within our 'focal awareness' of the coherent entity that we achieve. Clues and tools are things used as such and not observed in themselves [subsidiary knowledge can function as instrumental knowledge]. They are made to function as extensions of our bodily equipment and this involves a certain change of our being. Acts of comprehension are to this extent irreversible, and also non-critical. For we cannot possess any fixed framework within which the re-shaping of our hitherto fixed framework could be critically tested. [...] Personal knowledge is an intellectual commitment, and as such inherently hazardous. (Polanyi [1958] 1962 vii-viii.)

In redefining knowledge, Polanyi combined "ineffable" knowledge of skills and knowledge acquired by education.

> This ineffable domain of skilful knowing is continuous in its inarticulateness with the knowledge possessed by animals and infants, who [...] also possess the capacity for reorganizing their inarticulate knowledge and using it as an interpretive framework. [...] We may say in general that by acquiring a skill, whether muscular or intellectual, we achieve an understanding which we cannot put into words and which is continuous with the inarticulate faculties of animals. [...] [understanding in this manner has an existential meaning, understanding of language has a denotative meaning which is a special case of existential meaning]. To assert that I have knowledge which is inaffable is not to deny that I can speak of it, but only that I can speak of it adequately, the assertion itself being an appraisal of this inadequacy. [...] We acknowledge our own capacity to distinguish what we know from what we may be saying about it... (Polanyi [1958] 1962:90-1)

Polanyi also redefined the use of the word "true":

> We have re-defined the word 'true' as expressing the asseveration of the sentence to which it refers. This is closely akin to Tarski's definition of 'true' which implies, for example: '"snow is white" is true if and only if snow is white.' But Tarski's definition now appears to equate a sentence with an action. This anomaly may be eliminated by revising the definition as follows: 'I shall *say* that "snow is white" is true if and only if I *believe* that snow is white.' [...] Earlier on [...] I have denied the possibility of expressing the act

> of placing my confidence in a statement of a fact by a statement of the probability of this fact. [Suggested that Frege's prefix, assertion sign, should be read as 'I believe' as an endorsement of the statement.] Such a prefix should not function as a verb, but as a symbol determining the modality of the sentence. The transposition of an assertion sign [...] would correctly reflect the fact that such an assertion is necessarily attributable to a definite person at a particular place and time...We might have a better chance of achieving the purpose of epistemological reflection if we asked ourselves instead [of the quality of sentence of being true or false by impersonal criteria] why we do believe certain statements of fact, or why we believe certain classes of statements, such as those of science. [The antecedent beliefs justifying these statements are the self-set standards of science.] (Polanyi [1958] 1962:256)

It should also be mentioned again, that for Polanyi, logic did not mean only formal logic, but the whole range of informal logic the rational mind uses – including, and especially tacit inference, which is the power of the mind to make connections, to see the relation of part and whole.

His whole personal epistemology was a campaign against reductionism. In his opinion, Laplacean ideas were continued in the notion that DNA, its chemistry and physics, will be the ultimate explanation of living organisms. (According to Polanyi, DNA, rather, functions as a boundary condition irreducible to chemistry and physics) He described the hierarchy of organization of living organisms not only by analogy to the structure and function of the machine (to which Wigner objected), but also, he explained this organization (organismic principles) in his 1965 "The Structure of Consciousness":

> Living beings consist in a hierarchy of levels, each level having its own structural and organismic principles. On the mental level, explicit inferences represent the operations of fixed mental structures, while in tacit knowing we meet the integrating powers of the mind. In all our conscious thoughts these two modes mutually rely on each other, and it is plausible to assume that explicit mental operations are based on fixed neural networks, while tacit integrations are grounded mainly in organizing fields. I shall assume also that these two principles are interwoven in the body, as their counterparts are in thought. (In Grene 1969b:219)

For Polanyi, principles of this control are organizing fields, organizing principles, illustrated by how (according to C. H. Waddington) the development of the embryo is controlled by the gradient of potential shapes[28]. He also called the organizing principle organismic principle.[29] Polanyi's 1968 article, "Life's irreducible structure" (in Grene

[28] This analogy is controversial.

[29] This principle is not explained, but seems to be postulated as a parallel to his epistemology's "active element" added to the passive Gestalt. (See Jha (2002) Ch. 2.)

1969b:225) reiterates that organismic processes, as a level of explanation for living organisms, are irreducible. The progression is upward, with boundary conditions specifying the relations, from inanimate to life, each with a deeper level of significance.[30] – He also uses this organization as an explanation of (what in standard talk is called) the "objective" and "subjective" mode of seeing and to highlight the mind-body problem, as well as direct and indirect knowledge, which is of great importance assessing knowledge resulting from scientific experiments. In this article he noted:

> I have said that the analytic descent from higher levels to their subsidiaries is usually feasible to some degree, while the integration of items of a lower level so as to predict their possible meaning in a higher context may be beyond the range of our integrative powers. I may add now, that the same things may be seen to have joint meaning when viewed from one point but to be lacking this connection when seen from another point [as seeing patterns on the ground from an airplane, but not from the ground]. The relation of mind to body has a similar structure. The mind-body problem arises from the disparity between the experience of a person observing an external object, e.g., a cat, and a neurophysiologist observing the bodily mechanism by use of which the person sees the cat. The difference arises from the fact that a person placed inside his body has a *from*-knowledge of the bodily responses evoked by the light of his sensory organs, and this from-knowledge integrates the joint meaning of these responses to form the sight of the cat [from-knowledge, or from-to knowledge is direct, it functions from the body to what is in focal awareness]; whereas the neurophysiologist looking at these responses from outside has but an *at*-knowledge of them which, as such, is not integrated to the sight of the cat. [from-at knowledge is indirect, by looking at and interpreting data from an instrument – the neurophysiologist does not perceive the same thing as the cat does] This is the same duality that exists between the airman and the pedestrian in interpreting the same traces… [Similarly, in reading a sentence, the difference between a person familiar with a language and one not – the first understands the meaning, the second sees only letters]. Mind is the meaning of certain bodily mechanisms; it is lost from view when we look *at* them focally. […]. Owing to the existence of two kinds of awareness – the focal and the subsidiary – we can distinguish sharply between the mind as a from-to experience and the subsidiaries of this experience, when seen focally, as a bodily mechanism. […] though rooted in the body, the mind is free in its actions – exactly as our common sense knows it to be free. (in Grene 1969b:237-8)

For Polanyi, epistemological inquiries mean questions of "how do we know, and what do we rely on to know", rather than "is this statement logically true or false in a deductive process". There is a continuum between psychology and epistemology, and his re-definitions have bridged whatever gap standard interpretations saw.

[30] The isomorphism with epistemology is clear here, i.e., evolution as "achievement". (Polanyi [1958] 1962:388)

8. Explanatory gaps

Wigner, in his 1965 paper for the Unity of Knowledge Conference, "Epistemology of quantum mechanics – its appraisal and demands", was understood to say that the present (1965) state of the sciences hold that there is a gap between psychology and the physical sciences. (in Grene 1969a:22) Psychologists want to warn physicists, that their findings may be influenced by subjective considerations, and affirm that psychology aims to explain the processes of the mind by the laws of chemistry and physics. Wigner considered this direction doomed. Physicists warn that "the laws of physics give only probability connections between the outcomes of subsequent observations or contents of consciousness." (Ibid. 24) Wigner thought that the direction of quantum physics has more promise, although quantum mechanics will be a "limiting case of something more general". The body and mind form a unit, and a dualistic conception is problematic.

How does one understand the "gap" between the natural sciences and psychology? The natural sciences look for regularities of behavior of bodies (provide explanations, explore circumstances and conditions), the descriptive sciences including psychology, look for characteristics of these bodies (the older sciences, e.g. astronomy, have discovered a larger number of regularities, and transformed themselves into other disciplines). Seeking regularities, making progressively more encompassing theories, is a way to deal with the limit of the human mind to absorb particulars. These newer sciences also make discoveries, innovate (create new phenomena). – Psychology has begun to seek regularities such as theories of the subconscious, and Polanyi developed a theory of tacit knowledge, which can be examined before exploring the epistemology of physics.

9. Sorting out the Polanyi - Wigner dialog

Looking over the approximately ten year substantive correspondence on tacit knowing regarding the measurement problem in quantum physics, one can see the following:

9.1. Wigner's side:
Wigner is trying to find an explanation for the quantum mechanical phenomenon that observation changes what is observed. (Note that observation has two meanings, not clearly differentiated here: observation as the act of observing by a person, and observation as a result of that act, data). Wigner's hunch is that the mind's action, taken on the quantum level, influences the path of the observed quantum entity (in analogy with light influencing matter in the Compton effect), and that there is a potential explanation for this by a future hybrid science of physics-psychology.

He does think that the theory is incomplete; it is a puzzle to be solved in the future by such a new science.

9.2. Polanyi's side:
Polanyi thought this line of speculation is not fruitful. He considered this explanation, as all naturalized epistemological explanations, reductionist. According to him, there is no ontological difference between the "stuff" of classical physics and the "stuff" of quantum physics as explained by probabilistic quantum physics:

> For the laws of quantum mechanics coincide with those of mechanics for reasonably heavy particles. However, to be precise, the classical predictions of positions and velocities would have to be replaced by predictions of the probability distribution of positions and velocities. [footnote:] My argument will reveal my dissent from [...] [a] widely held opinion of great importance. In quantum mechanics any attempt at specifying the position and velocity of an electron must be defined in terms of the electron's interaction with a definite measuring instrument. The result will depend on the instrument chosen and will again be a statement of probability. [...] [T]he outcome of the observation does not depend here on the participation of the *observer*, but on the action of a *measuring instrument*, the result being the same for any observer. This contradicts on the one hand the view that the relation between the macroscopic and microscopic descriptions of an atomistic system is an instance of complementarity; and it shows also on the other hand that (contrary to a widespread opinion) the indeterminacy principle of quantum mechanics establishes no effect of the observer on the observed object. The supposed effect vanishes if we include the 'measuring instrument' in the 'observed object'. The latter becomes then 'the observed phenomenon' in the sense now accepted by Bohr's school of interpretation. (Polanyi [1958] 1962:392-3)

In essence, Polanyi is saying that Wigner's problem is one of interpretation – that this formulation of the question leads to unfruitful directions for an answer, to a physical, causal link as an explanation to the quantum mechanical measurement problem.

9.3. Their epistemologies:
It may be said that both Polanyi and Wigner constructed their ontologies in *parallel* to their epistemologies. Wigner's epistemology expressed in the measurement problem as knowing a quantum entity only when effected by the knower (unobserved entities whereabouts can be predicted but not "known") has a Kantian echo of *"ding an sich"*.

It is not the Kantian flavor to which Polanyi objected, neither did he object to Wigner's attempt to try to apply the notion of tacit knowing to the process. He objected to transfiguring tacit knowing into what he considered to be still a "physical" process, a reduction. To Polanyi, the tacit is a vector – in epistemology, it takes the form of integration, and in ontology it takes the form of emergence. (Polanyi 1966)

To him, the mind-body connection was not a question of causal explanation, but a question of "achievement", an emergence or innovation, a teleologically indicated vector. His notion of tacit is one "pulled by the goal" of the vector, not "pushed" by causes. If causal explanations require definitions and entities being specified, Polanyi's ontology cannot accommodate it. What he calls his comprehensive entities of the higher levels, although they rely on the lower physical levels in the hierarchy, are unspecifiable (the more complex an entity is, the more unspecifiable it is – our knowledge of it is unspecifiable by its elements).

9.4. Their ontologies:

Since their epistemologies are parallel to their ontologies, and for Polanyi, a template for his ontology, the following can be said: For Polanyi, the higher levels in the hierarchy of emergence are more real than the lower levels (thoughts are more real than physical objects). For Wigner, there are two kinds of reality: thoughts, and everything else. It is the primacy of thought in their ontology, and admitting the importance of non-explicit (tacit) thought in their epistemology of science, that they share. This may be the basis of Wigner's claim for his "Polanyian" epistemology.

However, Wigner was not satisfied with Polanyi's analogical descriptions of the mind-body connection, he found them vague. Wigner took Polanyi's analogy of the machine to describe levels of emergence as not applicable to living organisms. Wigner found puzzling, mystifying and non-explanatory Polanyi's analogy of synthesis of incompatible elements (described in the context of art and eastern religions) as providing a possibility for emergence of the mind and higher conceptual levels in innovation. So the decade long dialog about tacit knowing and the measurement problem was inconclusive – Polanyi was not convinced by Wigner that quantum mechanics had a different ontology than classical physics and therefore tacit knowing can be incorporated, and Wigner was not convinced that Polanyi found a satisfactory explanation for the body-mind connection. The dialog ended as the aging Polanyi's responses to Wigner grew less fresh and focused.

In a sense, both were looking for a bridge between *Naturwissenschaften* and *Geisteswissenschaften* to answer the mind-body problem. *Geisteswissenschaften*, in its old meaning would provide at least some of the three integrated elements they were looking for: reason (soft sciences), "feeling as" (art), and "feeling that" (religion), which could be looked at experimentally. For Polanyi, science and art exemplified "vision", as in insight, or Kant's "mother-wit" – and religion exemplified "awe". His extensive explorations were in the phenomenon of insight, although he made less successful forays into "awe". Wigner did not use art as an analogical resource, but on occasion he treated *"Geist"* as "soul", as an alternative to finding a Quantum Mechanical explanation the mind-body problem.[31]

[31] "A physicist looks at the soul." (1968), in Wigner (2001) 7B, pp. 41-3. Wigner was shifting between use of "consciousness" and "soul" according to the occasion and the audience.

10. A summing up and some questions remaining

A summing up and some questions remaining after this study on the influence of consciousness: How "polanyian" was Wigner's epistemology of physics? And remarks on extrapolating the Polanyi-Wigner discussion on epistemology through their essays. Current investigations.

We must note that most of the Wigner essays that fall in the ten-year period under discussion here, give the impression that Wigner was committed to the hypothesis that the reduction of a superposition is the work of consciousness. This is the function of the selective attention in this paper on the Polanyi-Wigner discussion on tacit knowledge. The larger question of the quantum theory of measurement cannot be explored here. For that study, and to investigate a trace the "element of consciousness" (Wigner's "Polanyian" epistemology) in this regard, see the works of A. Shimony (2002; in Wigner's *Collected Works*, vol. 3). Shimony as well as L. Diosi in "His Function and its Environmental Decoherence" (2004) pointed to the influence of D. Zeh on Wigner (along the lines of London & Bauer and von Neumann): consciousness is the phenomenon that could violate the linear laws of quantum mechanics. (d'Espagnat (1976: 263) Zeh (2000, 5) noted that a "concept of observation must ultimately be based on an observing subject." Diosi (2004:29-34) also pointed out that Wigner was an early supporter of what later was called "environmental decoherence". In this article Diosi said that Wigner was also impressed by Zeh's claim (d'Espagnat 1971:263) that a macroscopic body's inner structure (wave function) is influenced by its environment (it cannot be a closed system). A. Shimony referred to the same claim by Zeh as an influence on Wigner. (Wigner in d'Espagnat 1971:16-7)

Shimony stated (personal communication 3/29/2007) that Wigner considered hypotheses other than the hypothesis discussed in this article (i.e. the reduction of the superposition is the work of consciousness), but did not choose among them.[32] Shimony noted (Shimony 2002) that one of the proposed tentative solutions ("Wigner's solution") to the various problems in the quantum theory of measurement was that consciousness may play a role in the reduction of the wave packet, but, Wigner while evaluating Zeh's observation that the macroscopic system of the measuring apparatus is not a closed system, was skeptical of this observation's use to solve the reduction of superpositions.

Further remarks on the "dialog" through their essays: Between 1961 and 1963 both Wigner and Polanyi wrote rich and productive essays on the problem of the knower and the act of knowing. Wigner's were published in the collection *Symmetries and Reflections*. Three are relevant here. His 1961 "Two kinds of reality"

[32] A. Shimony offered the following references on this point, among others: Wigner (in Good 1962) "Remarks on the Mind Body Question." Endnote 11; d'Espagnat (1971). See also A. Shimony (2002) "Wigner's Contributions to the Quantum Theory of Measurement." Also, Shimony "Wigner on Foundations of Quantum Mechanics." In Wigner, *C.W.* vol. 3A, pp. 401-414.

was already mentioned above. This essay was of a dualist, idealist flavor. The person's consciousness is "absolute reality", and it is not permanent. All else, including objects, are "universal reality", with various degrees of probability, and it is useful to think of them as permanent. The two kinds of reality are not independent. As mentioned above, the greater reality of mind than of objects and the interlinking of the "two realities" echoes Polanyi's conception, although Polanyi has no category of "absolute".

Wigner followed this piece with a 1962 essay "Remarks on the mind-body problem", in which he discussed the "measurement problem", saying that to measure quantum motion, the sentient being's entrance changes linear equations to grossly non-linear ones. That is, consciousness influences the "observed" via the physical world (instruments) (Wigner 1967:182). He seems to give his own answer here, but is not satisfied with it. In this essay he gives a speculative solution (thesis?) to the mind-body problem: simple substrates give rise to simple sensations, while complex substrates give rise to complex consciousness. The mind is a "complexification". His thesis is that there is a correlation between the physical substrate and consciousness via the structure in which it exists. This correlation can be discovered only by two avenues: observation of human development, and the discovery phenomena in which consciousness modifies the usual laws of physics. (Ibid. 182) Is it possible that the question/thesis is put wrong – looking at the structure instead of functional relationships and properties – therefore it points towards no solution? Polanyi's "answer" to this is stated in "The Logic of Achievement" at the end of his *Personal Knowledge*. (Polanyi [1958] 1962, chapters 11-13)

Wigner's next essay was his 1963 "The Problem of Measurement," in which he presented the orthodox view and its critique. According to the orthodox view, possible states of a system, its state vectors, change in two ways: (1) continuously as a result of the passage of time, according to the equation of motion of quantum mechanics; and (2) discontinuously, according to probability laws, if measured (reduction of the wave function). This aspect is opposite to expectations in ordinary experience. The system consists of the object and the apparatus (observation on the apparatus). Wigner's criticism is that a full description of the observation is impossible: quantum mechanical equations of motion are causal and contain no statistical element – the measurement does.

These three essays look at the problem of measurement from various angles. However, Wigner did not seem to have made progress during this decade toward the "new science" he envisioned as the instrument for the solution of the problem.

In the same period of time Polanyi wrote several pieces that were collected in *Knowing and Being* – two of them discussed above ("Tacit Knowing" and "Knowing and Being"), as well as a reflection on his years of discovery "My time with X-ray crystals". In this 1962 essay he notes that discoveries bring forth some intrinsic potentiality of the intellectual situation of the field – it only *seems* to be a "flash of discovery", this essay, as some of his others, show the social "gestation" of a discovery.

His next 1962 essay "The unaccountable elements in science", speaks more directly to Wigner's puzzle. He reiterates here, that personal judgment cannot be replaced by the operations of explicit reasoning – tacit operations play a decisive role in discovery and in holding scientific knowledge. Pointing to Kant's reference to "mother-wit" when no rules of reason could be determined for application of rules, Polanyi holds that the ultimate agency for decision-making in a particular instance is personal judgment. – To solve a scientific problem is to see if there is anything to an anomaly. One must pick out a significant regularity, a pattern. The gift of seeing this marks a 'scientific genius' – mathematical analysis of patterns only formalizes the phenomenon, its significance is in the intuitive informal decision. Polanyi holds that a scientist attributes meaning to a sequence of events, to randomness in relation to potential order – e.g. noise in relation to true signal – to elements in certain configurations. The clues a scientists sees from which he integrates the meaningful whole, have to 'leap a logical gap' to integrate into a whole. It is a process of embodied knowing, a power of intelligence guided toward a solution, toward the achievement of a coherence. (Note, that for the mind to achieve an integration, a *simple partial* analogy is a gestalt perception). For a researcher, "a good problem is half a discovery". "A problem is something that is puzzling and promising…" a gift of sensing the direction toward a surprising solution. (Ibid. 117) It is interesting that Polanyi gave a new definition of external reality woven into this above description of a "good problem". He said: external reality is

> something that attracts our attention by clues which harass and beguile our minds into getting ever closer to it, and which, since it owes this attractive power to its independent existence, can always manifest itself in still unexpected ways. (Ibid. 119)

One might conclude that Polanyi, in one sense, is telling Wigner that perhaps his "problem" is not a good problem. He said that much in his comment on the measurement problem in *Personal Knowledge* (section 9.2 above). He also believed that Wigner's attempt to formalize the measurement problem and make it explicit in the way he did, missed the point, that Wigner's understanding of tacit knowledge as the last few steps of observation which creates the measurement problem in the observer's consciousness, was not the kind of tacit knowledge he has been describing, that Wigner's epistemology of quantum mechanics is not "Polanyian" (although he agreed that in human development, learning and understanding have a tacit component).

At the beginning I quoted Rohrlich's comment about seventy years of effort to solve this puzzle. It is to be seen whether the solution to the puzzle will eventually be provided in line with Wigner's hopes, by a combination of quantum mechanics and psychology/neurology by a notion similar to that of Penrose's micro-tubules within neurons within which occurrences of "quantum-coherent activity" constitute

consciousness[33] – or in line with Polanyi's speculations of informal logic and meaning-making couched in metaphors and analogies, a basically irreducible and emergent property of experience. Ultimately the "solution to the puzzle" will depend on what level of explanation we are looking for.

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[33] Penrose (1997), also see recent papers of Stuart Hameroff in *Quantum Consciousness* and *Journal of Biological Physics*.

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ANIMALS KNOWLEDGE: EITHER SIEVES OR HUMANS?

A false dichotomy in *Tacit and Explicit Knowledge* by Harry Collins1[1]

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ABSTRACT

In his book *Tacit and Explicit Knowledge* – while trying to explain to AI researchers why they should lower their expectations in the light of the findings about ourselves (referred to as *social cartesianism*) during the so-called 'Second Wave of science studies'– Harry Collins dignifies men (as opposed to computers) to such dizzying heights from where our common evolutionary roots with animals become completely invisible for him. In the paper I argue first that Collins forgets to defend his proclamations about our superiority and settles in incoherent logic, second that this seems unwise and we better remain curious about other living creatures around us to be able to learn more about ourselves (and not least to get still better in building intelligent machines). Thirdly introducing animals as experts I point to some discrepancies between this and his previous book *Rethinking Expertise* co-written by Robert Evans.

Keywords: knowledge, tacit, explicit, humans, animals, expertise.

1. Self-importance exposed

Having read the book *Tacit and Explicit Knowledge* by Harry Collins, throughout the pages I found myself wondering how I'm supposed to think about animals considering their „knowledge". Not that this would affect the book's conclusions or their importance – as Collins himself points this out[2]. The book wants to emphasize

[1] I hereby wish to thank László Ropolyi for drawing my attention to the questions of the evolution of knowledge, Ádám Miklósi for giving priceless sources of modern comparative cognition, Karl Hall for introducing me to the topic of expertise, and everyone at the Polanyi circle.

[2] As Collins himself points out in the first chapter: „It may be that dolphins and chimps or even some other animals share the interpretative abilities of humans to some small degree. Whether this is true or not matters not in the least for this argument, since the argument covers entities with interpretative abilities; the proper extension of 'entities with interpretative abilities' does not have to be settled for the logic to remain coherent." (Collins 2010:25, fn. 9)

the difference between humans and *machines* by pointing out our species' peculiar abilities (Social Cartesianism – see later) and also to demystify the supposedly misused term *tacit*. Being amazed myself how much money is spent worldwide on AI projects engineered by men never even heard the name of Wittgenstein I think we can be grateful to Professor Collins for trying to forgo so much disappointment.

But the treatment of animals in the book seems quite problematic even if for Collins this remains a secondary question at best. Though at the beginning for a short moment his intentions seem honest to elaborate on all the differences among animate and inanimate things, the book gets soon impatient and disqualifies animals suddenly from the realm of knowledge. On page 6 we read „The starting point is to think of knowledge as „stuff" that might also be found in animals, trees, and sieves and then try to work out from this starting point what is that humans have" in the same paragraph alluding to Wittgensteinian philosophy he proclaims „knowledge cannot be found in the absence of the activities of humans" and still on page 6 that „it remains the case that, in the last resort, humans are the only knowers".

Of course to be able to dig such a big hiatus between humans and animals Collins breaks with the Polanyian approach of the tacit completely, and argues that the "idea of tacit is parasitical on the *idea* of the explicit" (Collins 2007:7). So reversing the Polanyian approach that 'all knowledge is rooted in tacit' he believes that creatures unable to explicate their mental states can't be assumed to have tacit knowledge either. And though this *tension rule* seems a good rifle-pit to indicate differences between humans and computers, it jumbles the notions of cognitive capacity and communicative abilities, leaving nothing but confusion about the meaning of the word *knowledge*.

This application of ideas seems even stranger given that Michael Polanyi shows the deep common roots of intelligence in men and animals[3] in Personal Knowledge spectacularly (coining the term: *active principle*). And while Polanyi – like Collins – is also ready to point out the source of the big difference between humans and other animals (namely: language) his explanation of the evolution of language as a continuous progress from animal cognition (by first learning the articulation of in-articulate representations, and then applying operational principles to the symbolic representations[4]) seems a much more exuberant analyses of how our mental capacities might work. More importantly, one of the precious clues *Tacit and Explicit Knowledge* gives to the Polanyian understanding of the idea of tacit knowledge is shading light to the socio-historical component of its birth: the dawn of computers.

[3] Of course beside Polanyi's account the whole theory of evolution started by Darwin believes the same: that all our cognitive abilities do emerge from animal cognition.

[4] See Personal Knowledge, especially the fifth chapter: Articulation (Polanyi 1962).

The pioneers of the idea of tacit knowledge, reacting to the enthusiasm for science and computing typical of the 1940s and '50s that made the explication of everything seem easy – no more than a technical problem on its way to be solved – had to fight to create space for the tacit, and, as a result, they made it into something mysterious. (Collins 2010:7) [5]

Then again, seemingly understanding the stake of Polanyian philosophy Collins doesn't hesitate to muddle up the concepts, and even while trying to trivialize the notion of tacit he admits its ubiquity:

> But nearly the entire history of the universe, and that includes the parts played by animals and the first humans, consists of things going along quite nicely without anyone *telling* anything to anything or anyone. There is, then, nothing strange about things being done but not being told – it is normal life. (Collins 2010:7)

And so the paradox logic of the "parasitical" conception of Collins becomes obvious. The term tacit knowledge makes only sense when it can be contrasted with explicit knowledge. The strange rule applies to animals as well, since according to Collins things or animals incapable of explicating their knowledge can't have tacit knowledge either – which means no knowledge at all. As the book states: „There is no animal explicit knowledge and, consequently, no contrast that would make sense of the term tacit knowledge in respect of animals." (Collins 2010:80) „In fact, they don't „know" anything: they just transform strings. Cats, dogs, trees, and sieves just hunt, sniff, grow, and sift in the way that a river flows". (Collins 2010:78) But segregating humans from animals so desperately is not only futile in the process of understanding our species true capabilities, but represents such a narcissistic self-conceit of human race that would make even most believers of creationism blush.

2. Forms of knowledge among animals

2.1. The cases of explicit communications

Now it might be time for me to confess that I do have two dogs, and if only because they have blinded me with their cuteness: these pronouncements seem pretty fragile

[5] Note that probably this explains only part of Polanyi's motivations since his opponent was positivism. The important difference remains nevertheless, as pointed out among others by Mihály Héder and Stephen G. Henry, that while Collins deals with *knowledge*, Polanyi speaks about *knowing*.

And even if for Collins the brain-functions of a squirrel might be easy to understand, most ethologists would be dubious whether only "the pioneers of the idea of tacit knowledge (...) made it into something mysterious".

for me. Human language is not the single way of explication and just because animals don't speak as eloquently as humans do they can – and often do – explicate themselves: if we accept the definition of the term by Collins. In his book the basic elements of explication are *strings* ("bits of stuff inscribed with patterns" (Collins 2010:16), not being meaningful in themselves), and communication takes place when an entity "is made to do something or comes to be able to do something that it could not do before as a result of the transfer of a string."(Collins 2007:20) And an entity "will have been enabled to do something if it can use what has been transferred in some productive way – [...] having new and useful knowledge." (Collins 2007:21) Along these lines Collins argues that if while watching a soccer game someone obstructs my view, a „gentle push to move your bulk" is considered a *string* (Collins 2010:57), and thereby already a form of explication: since easily interpreted as telling „please move aside". Given this it seems trivial that when my dogs drill their muzzle under my hand it should be also considered as a form of explication: they ask for scratching. Accordingly when intensely stretching in "upward facing dog" pose in the hall they explicate they want to go for a walk, when during a stroll they swiftly turn back and look up to me they let me know they hear a car coming, and so on.

It's true though that some ethologists deny that dogs would be really animals (Csányi 2012:45), since the ten-thousands years of domestication and co-evolution made them very humanlike creatures and extremely sensitive to human communication (Morell:2014). But explication is not a unique habit of dogs, in fact most animals communicate in many explicit (audible, olfactory, visual or other) ways – using strings undeniable, which are interpreted by companions. The example of bees seems so obvious they are even mentioned by Collins himself (Collins 2010:29). Collins is of course perfectly right, we probably shouldn't call their dance a language: but if it's explicit or not is hardly a question! The strings used by bees are so unambiguous even humans are able to interpret it – and important decisions of the bee hives are made with the help of these enabling communications.[6]

At the end we might consider not wanting to call knowledge whatever it is that animals possess – the book suggests the world *mechanism* instead – but for this we will have to find a completely new reason: the 'incapability of explication' argument is insufficient here. For if we really tried to treat animals and humans "as undifferentiated entities" also according to the 'tension rule' we should probably believe that just as with humans if a small part of someone's knowledge she herself can somehow explicate (e.g. 'how I balance my bike' – theoretically explicable for Collins) then all other parts of her knowledge might be righteously called tacit ('how to drive in traffic' – a case of *collective tacit knowledge* in the book). The extreme bias of Collins against animals is probably most transparent in his treatment of what he

[6] For closer analyses see Riley 2005.

calls *somatic tacit knowledge*. Using the famous example of bicycle riding he argues that contrary to Polanyi the technique of balancing is nothing mysterious and even Polanyi himself explicates the rules of bike riding "just three pages after he says they are tacit". (Collins 2010:100) Collins explains that if "we rode our bikes on the surface of a small asteroid with almost zero gravity so everything happened much slower, we ourselves could probably use Polanyi's rule to balance." (Collins 2010:100) "This is knowledge that is tacit because of our bodily limits even though it can be explicated" (Collins 2010:101). So it turns out that for Collins the mere possibility of an explication is enough to count something a knowledge – but only in the case of humans. Whereas in the case of animals even obviously explicit communications are denied to carry meaning. But what's the point in prohibiting the use of the word 'knowledge' while witnessing the many ways animals communicate explicitly? The 192 pages of *Tacit and Explicit Knowledge* give little help here.

2.2. The possibility of the "social cartesianism" among animals

Though abandoned swiftly in the book, the supposed rule of 'undifferentiating among entities' sounds quite defensible. Obviously not just because Polanyi (let alone Darwin) argued so convincingly about our common heritage with the cognition of animals. Modern research in ethology (more precisely: comparative cognition) has shown many times that animals manifest capabilities resembling very much to what Collins refers to as *collective tacit knowledge*. For Collins this capability – also called Social Cartesianism – is what makes us really human and embodies our culture: "actions that require different behaviors for successful instantiation depending on context and require different interpretations of the same behavior depending on context." (Collins 2010:125) The main example in the book is bicycle riding in traffic, which "includes understanding social conventions of traffic management" and "involves knowing how to make eye contact with drivers at busy junctions", and which is why "bike riding in Amsterdam is a different matter than bike riding in London, or Rome, or New York, or Delhi, or Beijing." (Collins 2010:121) For Collins this is the final frontier where robots shall never be able to follow us.

Now in the case of animals we can agree that whatever they do they don't use language – then again of course language is seldom if ever used when riding a bicycle in Amsterdam or elsewhere. Being so proud of our species abilities to engage in social life we might be surprised how many things animals can comprehend in similar ways. Members of many different species are proven to keep track of one another individually and consider past acts when deciding how to act with whom. Corvids for example, living in large social groups, not only remember where their companions have cached food, they also learn to remember individually who saw them caching their own and develop strategies accordingly to reduce the chance of being pilfered (Clayton 2007). Jackdaws and Pinyon jays keep track of whole social

hierarchies and records of who won the last fights and even use transitive inference to decide who to help in an upcoming fight (Paz-y-Mino 2004; Mikolascha 2012). Though usually we don't treat fish as extremely intelligent species, they can also learn about third party relationships by eavesdropping: and not only among themselves (e.g. Siamese fighting fish – Oliveira 1998), but some even follow the complex social networks *inter*specific. Since there's an opportunity to cheat, the mutualism among cleaner fish and their clients depends mainly on the efficiency of the *distinctive reputation* of the cleaning fish – which some clients (e.g. Australian reef fish) are really good at (Bshary 2006).

Social intelligence is naturally of great importance among many mammals: vervet monkeys for example are famous for learning acoustically distinct alarm calls – and apt reactions – for three different predators (snakes, leopards and eagles). What's more they not only learn to discriminate harmful raptors (hawks and eagles) from equally large but harmless birds (storks and vultures), but they also rank the authenticity of each other's calls continually. And if a partner is starting to give false alarms they soon learn to disregard the calls of the "paranoid" fellow (Chenaya 1988) – beautifully satisfying the criteria of Collins for context dependent interpretation. At last we can mention Chacma baboons, members of the primate order. Living in complex societies the evolution of the baboons led to developments in sensitive interpersonal skills: they pay minute attention to the affairs between other specimens and approach, hide or try to deceive everyone accordingly (Crockford 2007). Considering that among baboons consortships may change many times a day this means quite elaborate social intelligence. Again, it might still be possible to argue that we shouldn't call these interpersonal skills in animals 'social cartesianism' but the examples Collins gives us are completely out of line for that claim. Denying that animals can outperform sieves is untenable from a cognitive stance.

3. Animals as experts

Collins draws our attention to the importance of expertise. In his book written with Robert Evans in 2007 *Rethinking Expertise* they claim that the most solid forms of knowledge and science per se are found when looking for different experts, and that it crystalizes in how people gain authority as knowers in our societies. However animals can also function as experts. In the everyday life of human societies we find them all around, often not just helping to engage our leisure time but even assisting our workflow. Maybe Jared Diamond exaggerates when insisting that domestication is the "most momentous change in Holocene human history" (Diamond 2002). In any case awareness of the presence of animals in our societies is not a luxury for pet-lovers, but a necessary component in understanding how human societies emerged and endured.

Probably dogs would come again to our minds in the first place: chasing away burglars and thieves from our homes, shepherding the live-stock, pulling sledges were all important parts of human history, even if by now we've learned to substitute them with alarm systems, electrical fences and motorization. But we still use dogs every time we try to rescue people from demolished buildings after earthquakes, or when trying to detect some dangerous or illegal materials. The social trust in the skills of these dogs is so strikingly unanimous around the globe no scientist or other human expert could have ever dreamt to enjoy. And if – as the main demarcation criteria for real sciences offered by Collins and Evans – we try to find the "Locus of Legitimate Interpretation" in the case of rescue dogs we have to realize that the locus is extremely on the "left" in the Chain of meaning (Collins 2007:121). That is all the rights of interpretation belong to the producers of the knowledge (dogs and maybe their keepers) and none to the consumers of the knowledge (the people rescued and their relatives). According to *Rethinking Expertise* (written only 3 years before *Tacit and Explicit*) rescue dogs seem to represent one of the strongest forms of expertise imaginable – in no way excludable from our club.[7]

And the line of examples goes on. Recently more studies report (McCulloch 2006) about dogs being able to diagnose different kind of cancers at inchoative stage, which is of high importance given that the survival chances are tied to early diagnosis and that clinical detection is usually problematic. Dogs are nevertheless absolutely not unique in being able to help humans in societies. Sniffing can be better done by wasps and rats, approaching burglars might be signified as well by crickets, carrying weight is usually more efficient with elephants or horses – and some tasks are completely out of a dog's realm, like chasing mice to protect the larder, or underwater echolocation (being a special skill of dolphins used mainly in warfare). What might be even more important is that pets seem to have a very direct effect on humans well-being: and given the exponential growth of the wellness industry (from psychology through sports to nutrition crazes) the rising need to cherish ourselves is an important phenomenon. So if nutrition professionals and psychologists count as experts in enhancing the well-being of their customers, than the animals capable of the same thing must be recognized as equally important parts of our societies. Again even fish count: aquariums in the waiting rooms of dentists have been used over decades to relax the patients with clear benefits (Katcher 1984). Using animals

[7] Nevertheless Collins is perfectly right that animals differ from humans in very important aspects, and that we shouldn't forget about the differences. According to contemporary comparative cognition studies one main discriminatory item as pointed out correctly by Collins is *language*. The other, probably in close relation to it, is *theory of mind*. However close animals – potentially apes or dogs – might get to these abilities, they unambiguously fail to reach human levels. But inferring from this that animals are equivalent with sieves seems strange. It seems to be a case of false dichotomy.

in different therapies is also common place at least since Freud's dog Jofi: dogs[8], cats, rabbits, horses (Benda 2003) and even dolphins (Nathanson 1997) are used in many ways (Macauley 2004) to help to improve the life of disabled children or adults dealing with addictions and emotional issues. Even without the involvement of any psychotherapist methods, the simple fact of having a pet at home seems to improve the life of the owners (Anderson 1992; Serpell 1996).

4. Conclusions

When Harry Collins tries to draw the contours of ***social division of labor*** all these activities must mean something to him as well. It's quite obvious that at least some of the aforementioned skills of animals make them experts[9]. And can we believe that expertise is affordable without knowledge? We can't. In ***Rethinking Expertise*** Collins himself did not think that either. Regardless of how we would like to call these skills – knowledge, expertise, competence etc. – it is obvious that animals too have it. And even if this doesn't affect the main conclusion of the book regarding computers, the otherwise noble attempt "to resolve these confusions and (...) to produce the coherent account of tacit knowledge" (Collins 2010:ix) fails in the case of animals quite explicitly. Contradicting Polanyi's famous statement leads to more problems than solutions; and accepting the 'tension rule' makes the new notions of tacit and explicit knowledge more incoherent.

Of course for Collins the main target is the actor-network theory (ANT) of Latour. Rejecting the human-centered approach of the sociology of scientific knowledge (SSK), ANT treats humans and non-humans (animals as well as things) symmetrically – rendering itself "impotent" (Collins 2010:166), and also being incompatible with the idea of Social Cartesianism. And though this symmetrical understanding by Latour might be misleading (making humans as unaccountable as a battery), doing the extreme opposite and handling humans and non-humans completely asymmetrically and treating animals and inanimate things symmetrically seem equally untenable from Collins.

[8] See at http://prisondogs.blogspot.hu/

[9] This seems to be true whether we accept the definition of expertise by Collins or others. Beside a form of knowledge expertise might be defined also as exceptional performance (Ericsson 1996) or as a social construction (Agnew et al 1997). Nevertheless as William S. Helton very consistently argues non-humans can't be excluded from expertise based on any product-oriented definition of it (for Collins this probably means the strings but also the "enabling" through communication): "Whether expertise is regarded as a social label, exceptional performance, or knowledge, some non-human animals appear able to satisfy the definition." (Helton 2005:72)

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EXPLICIT KNOWLEDGE IN THE PHILOSOPHIES OF HARRY COLLINS AND MICHAEL POLANYI

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ABSTRACT

In this article I analyze Harry Collins' explicit knowledge theory. Collins proposed this theory in his book *Tacit and Explicit Knowledge* and applies an undoubtedly novel approach in analyzing the supposedly straightforward concept of explicit knowledge. He discovered that while tacit knowing is natural and ubiquitous, it is explicit knowledge that is strange and needs more scholarly attention. In order to characterize the process of knowledge explication he focused on the physical transfers that take place during communication. His central concept is the *string* that is transferred between the parties involved when communicating. In my critique I bring to light the limits of this approach by proposing examples that are hard to understand based on string transfers yet remain relevant to the original question. I then attempt to define the Polanyian concept of explicit knowledge, which I think can be easily reconstructed based on *Personal Knowledge.* Finally, I call the reader's attention to the major differences between Collins' and Polanyi's theories on tacit and explicit knowledge.

Keywords: tacit knowledge, explicit knowledge, strings, social cartesianism.

1. Introduction

Harry Collins wrote *Tacit and Explicit Knowledge* (TEK) to clarify the title's much-debated notions. His main strategy for reducing ambiguity is to reduce these two notions. He investigates the physical processes of knowledge transfer, because the physical aspect is much easier to observe and discuss. He believes that the mysteries surrounding abstract terms, such as icons, signs and codes, divert the investigator's attention from what is most important as well as easiest to handle: the physical relations between physical entities.

Rather than begin with the usual question of what tacit knowledge is, Collins aptly turns the question on its head and asks what explicit knowledge is (TEK:7). By clarifying explicit knowledge, he can define and handle tacit knowledge more easily. As he points out in the 2011-12/1 edition of *Tradition and Discovery* (Collins 2011), previous literature does not address the notion of explicit knowledge nearly as

often as it discusses tacit knowledge, yet he feels the former is equally interesting if not more so. To remedy this deficiency, he dedicates the first three chapters of TEK to the explicit. Then, the second three grapple with the tacit. The present article will not discuss at length Collins' system of tacit knowledge so it can focus on his concept of explicit knowledge addressed in section 2 of this article.

To give Collins's fundamental assumptions some context, in section 3 I compare them to Michael Polanyi's book *Personal Knowledge* (PK). I will attempt to reconstruct the Polanyian concept of explicit knowledge by mainly examining his "Articulation" chapter. This comparison will help me to arrive at some broader conclusions about communication theory I include in section 4.

2. Explicit Knowledge in Collins' TEK

For Collins, explicit knowledge is knowledge that has been successfully explicated. He aims to describe the process of explication, and he then enumerates what can set back or prohibit this process. By explication he means the demonstration of reduction of the capabilities in question to the transfer of so-called strings (see the next chapter).

The identification of different kinds of obstacles of reduction allows him to set up a classification of tacit (inexplicable) knowledge (TEK:1).

2.1. Strings

To carry out the reduction, Collins needs a firm foundation, so he sketches a universal metaphysics with two central concepts, *strings* and *entities*. Both are physical beings. It is important to note that his string notion has nothing to do with the String Theory of physics or with the popular, versatile data type of computer programming, also called string. This string is a piece of matter that is *inscribed* with *patterns*. It can be anything that is neither featureless nor random (TEK:16). Collins makes no sharp distinction between string and entity, so the strings can be entities and entities can be strings, depending on the context (TEK:16).

Strings interact with entities in different ways. They can interact physically, such as when two billiard balls collide. Collins' system includes a special sub-type of physical interaction, which is when the pattern on a string is *inscribed* to the entity, such as when a printing press embeds letters into paper.

To understand Collins' explicit knowledge notion, one must first examine his concept of communication, which is another sub-type of physical interaction (he does not make entirely clear whether all communication is inscription). He explains, "*A communication takes place when an entity, P, is made to do something or comes to be able to do something that it could not do before as a result of the transfer of a string.*" Sometimes, communication is easy; other times, one needs to exert much more

effort to make it successful (TEK:21). Collins distinguishes five different conditions for successful communication that represent five levels of effort from the easiest to the hardest.

2.2. Conditions of communication

In Collins' enabling *condition 1*, everything is in place on the receiver's (P) side. One single string transfer to P leads to immediate success and enables P to do something it could not do before. This condition probably seems straightforward, but Collins' example is worth discussing here.

In his example, a human enters the formula of an arithmetic addition into a computer that immediately produces the result. In this case, P is the computer. It can perform an action that it never could do before after receiving the signals from the keyboard, and this action is displaying the result of the calculation. We should note that this is exactly what the *made to do something* part in the definition refers to. In this communication definition, the sender can have control over P; moreover, only the sender can evaluate whether the communication was successful or not.

In case of *condition 2*, the simple string transfer does not lead to success. An additional transformation of the string is necessary for success. In Collins' example, a full stop in a printed text might contain a sentence or instruction in micrometer scale. Showing the stop unchanged will not result in success, but with a magnifier, the communication can be made successful. At this point, Collins decides not to specify who is carrying out the transformation.

Moving on to *condition 3*, the transfer of an additional string is necessary to make the original string work. For example, if my computer does not have a calculator program installed on it, then I must install one (additional string transfer) before the original string (the arithmetic formula) will work.

In *condition 4*, even the transfer of a longer, complemented string does not result in success, so a "fixed" physical change in P is necessary. For instance, I might need to add a new memory module before I can install the calculator program. As another example, a weight lifter might be properly instructed how to lift a 120 kg weight, but weight training still needs to take place for successful lifting.

Finally under *condition 5*, further change is needed beyond physical change. To make the string transfer successful, P would have to receive via strings the ability to understand the language. For Collins, this case is different from the other four in a fundamental way. His position is that language ability and other social abilities are different from any other abilities. Later, he describes why he does not believe that language ability can be transferred via strings. He claims that socialization is the only known way that can enable a P entity to understand a language.

2.3. Curious cases of communication

Collins tries to define communication and its conditions in the most comprehensive way, probably because he wants to give these definitions a strong reasoning power

in various situations. If one has reasoning power, then one can use them to evaluate cases of communication that Collins did not mention.

Before we begin, let us note that although "fixed" physical change appears in the description of condition 4, all kinds of physical transfers, including the transfers in condition 1, must result in a physical change in this system of thought. That is, in every case of communication, a string sent to P makes it become P', and the latter entity is able to do something that P could not do. The conditions of the communication designate either the extent of the change or the nature of the change; otherwise, we would be able to determine where P ends and the outside world begins. Why should we accept that installing software on a computer is not under condition 4 when we know that the installation process also results in a permanent physical change on the hard drive of the computer?

If P is really a similar physical being to strings, then we have the following degrees of physical change.

Let us analyze the example of an individual using a calculator to add up numbers. In condition 1, the incoming string (electric signals in this case) is intermingling with the electrons that were already there, which ultimately results in a change on the liquid crystal display (LCD). Then, another impulse (from a different button, like C) clears the LCD and sets the calculator into a similar state as its initial one. (Yet surely, it will not be precisely the same physically.)

Complying to condition 2, the transformation results in a larger physical change in the string, but the effect of this modified string is similar to the effect in case 1. Condition 3 results in some kind of memorization (the additional string must be remembered or understood somehow) that takes the form of fixed physical change. Condition 4 seems to be similar to condition 3, but it appears to manifest to a larger extent. Here, a new version of the previous question arises: should we always assume that the physical modification of P according to condition 4 enacts a successful communication? Or, should we think that inserting a memory module is a successful act of string transfer? If not, how is this case different from installing software?

Collins does not want to give detailed descriptions of the exact characteristics of entities, because he hopes that the difference between the kinds of entities can be established by the investigation of the string transfer question (TEK:15). Furthermore, his baseline theory asserts that anything can be a string or an entity, depending on the context (TEK:16).

Because of this, the distance between P and P' seems to be arbitrary and so do the boundaries of different P-s. Thus, a critical reader might interpret the following as successful communication: a man in a traffic jam is told that he can escape the situation by flying away. This string transfer does not result in a successful communication, but with a certain modification of P – putting a jetpack on his back – communication becomes successful and P' flies away. Yet the question of whether this kind of change is allowed under Collins' fourth condition remains.

If P' was still unable to fly and became only P+jetpack, then would this change be valid? To take another example, let us say that P is an old, gigantic computer, and it must undergo a change in order to respond to users in Hungarian. If I were to hide inside this computer and type answers to the user's messages, then would this be a valid change? Most probably, Collins would reject this example, because P (the computer) was absurdly modified or because my modification was only a trick and not a true modification at all. Therefore, one should be able to establish the difference between inserting a memory module and inserting a human.

Quantitative questions also arise. I can make P, a plastic plate, play chess by soldering integrated circuits and other elements on it and finally installing software. Between P and P', there is a huge gap, but it seems that this process might qualify according to the theory of communication. It would seem even more valid when one considers the case of building and programming a bicycle-riding robot (one of Collins' examples), which seems to be similar. Perhaps if we had a means to disqualify hardware changes but allow software changes, then we could make the distinction.

Another question is whether an organization or a group can be an entity. To my best knowledge, no one in our department speaks Japanese, so we could not read a Japanese letter. However, if the sender of the letter also sends along a Japanese interpreter, then our organization is made to understand Japanese – without socialization. In this case, we can say that a university department is not an entity or that a Japanese interpreter is not a string or both. However, such arguments would be much more restrictive than what is indicated in the phrase, "strings are entities and entities are strings" (TEK:16).

Perhaps this foreign language concept of communication includes cases of ostensive teaching. If I ask a foreigner in downtown Budapest, "Hány óra van?" then the communication will probably not be successful. However, if I also point repeatedly to the part of my arm where people usually wear their wristwatch, combining the previous air strings with visual strings, then the foreigner will be able to show me the time. She might also learn this Hungarian phrase. [1]

Finally, questions might arise about the time dimension of communication. Can someone say that a child's growth from conception to adulthood is nothing other than a long series of string transfers? This definition seems to be formally plausible if we consider an isolated child with only one parent. With an argument like this, someone could make condition 5 transfers look like mere variations of condition 4 transfers, thus attacking Collins' Social Cartesianism (see later).

The counter-arguments to this example could be that 1) only a collective of humans can transfer the ability to use a language and that 2) children are born with the essence of the abilities necessary to understand language, which then only

[1] One wonders whether the scene with the two men on the front cover of *Tacit and Explicit Knowledge* represents this ostensive definition.

needs to be developed. With the second argument, one would also state that the proper language skills of the human as an individual must precede the language of the collectives.

But Collins, by closing down the possibility of condition 5 communication from animals and computers, probably only means that it is impossible for someone to construct a machine or somehow modify an animal until the resulting P' entity will understand language.

In addition, there might be a way to disqualify the transfer of the Japanese interpreter from conditions 3, 4 or 5 by stating that strings must be artificially created by the sender party. Specifically, the sender of the Japanese letter must inscribe patterns on some medium and then transfer it. For example, she could type a formula into a calculator, write software, etc. More precisely, she might just buy the software from someone who artificially created it. After expanding the notion of the artificial, we would probably find that artificial things must be intentionally created by inscription. Sending a Japanese interpreter is just as much a misunderstanding of string transfer as placing a human into a room-sized computer. Human relocation is a natural event and does not involve string inscription. On the other hand, a bicycle-riding robot is entirely artificial, so we might say that only the latter is a result of successful string transfer.

By following this chain of thought, we could say that raising a human child is not string transfer or string transfer accompanied with physical change, because the physical change (in condition 4) must be artificial. The development of a child goes on rather naturally, and its successive stages are not caused by the parents in the same way as the development of a robot is caused by an engineer.

2.4. Hidden ontological level in Collins' definition of communication

It seems that Collins allows (it is difficult to resist using the term "explicitly" here) everything in the category of entity and string. In reality, only humans, computers and possibly animals are implied to be Ps. His examples also feature all three (e.g. TEK:9). Moreover, it appears that he thinks these entities possess a certain structure: they are beings with input channels and an inner state, and they possess the ability to process patterns. In effect, valid entities resemble computers. In *condition 1*, the sequence is input –> processing –> output. In *condition 2*, the input is incompatible, so it is converted first. In *condition 3* the input is not enough, so additional input is needed. Up to and including *condition 3*, P remains unchanged (for a moment, let us set aside my criticism in the previous section about the necessary change of P to P'), because, curiously, people usually do not consider the inner state a physical part of the system when they discuss systems. In contrast, the system itself must be changed in *condition 4*. This change can be the insertion of a memory module, the development of muscles or similar alterations. If we fully accept the hidden premise that Ps are pattern processing systems, then the man with the jetpack is not a problem anymore. He is part of a flying second-order system containing two

individual systems, and one system is controlled by the other. Under this assumption, conditions 1-4 fall into place.

Moreover, the statement that everything can be an entity but also a string is still defendable under this assumption. For example, when programming a pacemaker, the pacemaker is a P entity that is made to do something as a result of the communication. When a surgeon places it in a patient, the pacemaker becomes a string that makes the patient play tennis again. (Alternatively, this can be interpreted as a physical change under condition 4).

If we do not assume the premises that a) P is a pattern processing system, b) the boundaries of the system are clear, c) its embodiment's structure is separable from its dynamically changing state; then we do not have any means to explain the difference between conditions 1-4, because they would differ in only the extent of the change.

2.5. Social Cartesianism

Condition 5 is fundamentally unlike the previous conditions. Collins makes it clear right from the start that he assumes a Cartesian position on this final condition. This position is a kind of dualism in which there are two worlds, the *meaningful world of language* and the *physical world of strings* (TEK:28). Between the two worlds lies a metaphysical discontinuity. Just like in any kind of dualism, the problem of interaction between the two world surfaces here, and Collins addresses it immediately in the "Confounding Strings and Languages" subchapter (TEK:27-9). Here, he explains that the sender of the message makes an effort to transform the language to strings. Then, it is transferred in the physical ways that strings are usually transferred. At the end of the transfer, it is interpreted by the receiver, which – unlike pattern processing – is an operation of more than a physical nature.

Creating a *condition 5* communication would involve the transfer of a non-physical capability of interpretation. Currently, Collins sees no way to do that other than socialization. This metaphysical discontinuity also explains why bringing up a child (socialization) is not merely a sequence of string transfers and physical modifications. Instead, the child is affected in non-physical ways by the community that enables her to access the non-physical world of language.

It is interesting that accepting this dualism is not a logical necessity but rather a matter of belief, the faith of which is a "hostage of fortune" (TEK:144). Collins allows that at some point – although it is not yet imaginable how – someone will be able to construct a machine that is able to use language. It remains unclear whether this would mean that Social Cartesianism is wrong or that machines are also able to access the world of language after all.

Collins believes social relations are irreducible, and therefore language is irreducible (TEK:124). He talks about two kinds of beings (although according to my analysis, there is a third kind, the pattern processor system) and the interactions between

these kinds of beings. However, he does not explain how the first irreducible society is materialized. The lack of a story about the origin raises a number of questions. If the world of language did not exist in pre-human ages, then when did humans create it? Moreover, collectives, subcultures and languages continue to develop today. How many worlds of meaningful languages are there? How many people must speak a language to make it meaningful? Can we observe the jump through the metaphysical gap?[2]

2.6. The notion of explicit

The hardest part of reading TEK is accepting Collins' ambiguous ontology. Once we have done so, we can understand the notion of explicit knowledge with relative ease. Explicit knowledge is any knowledge that can be transferred via strings (e.g. *condition 4* communication is not explication, because it changes P. *Condition 5* would probably also change P if this condition had the ability to do so.)

This notion also supports that in Collins' worldview, there is a first, hidden gap[3] between pattern processor systems and other physical things. Otherwise, the pattern that is stored inside a system would require an immediate a physical change. In *chapter 5*, we can see that he makes a strong distinction between hardware and software (TEK:100). In this sense, the construction of the bicycle-riding robot cannot be explication. However, if we already have a robot with the proper structure, programming it *is* explication. This also means that the knowledge of riding on a bicycle is assumed to be in the software and not in the software-hardware unit; otherwise, it would not qualify as fully explicable, because creating hardware is not explication.

In my opinion, this part is the second most problematic assumption in *TEK* after Social Cartesianism. On the one hand, there is no metaphysical discontinuity between strings and entities as long as entities are not humans – on this end, we have a flat ontology (See Lowney 2011). On the other hand, the non-human P entities can be made to do things in the physical world after receiving physical strings, but P in this case remains physically unchanged, because it is a pattern processor system that interacts with the physical world with non-physical properties, such as inner states.

2.7. The evaluation of AI

An interesting analogy in the book is Collins' comparison of the human's capacity to use language to one of the simplest computers in existence – the Chinese room. Referring to this computer doesn't seem to be an effective argument, because the

[2] Some answers to these questions might be reconstructed from Collins' *Socialness and the Undersocialized Conception of Society* (1998), in which many central ideas of TEK is already present.

[3] A second gap lies between humans and all other phenomena.

Chinese room is stateless, has no recursion and uses no feedback. The combination of these qualities with this computer's unconditional nature and single input channel makes it unlikely to produce anything interesting.

The definition of a Chinese room is a machine that can only answer to pre-programmed questions. Its role in Collins' book might be to represent all kinds of computers while still being easy to understand. However, the Chinese room does not serve as an analogue for the majority of real computers that have qualitatively more computational power as the program languages for real computers are usually Turing-complete.

It would be interesting to evaluate a more successful system in Collins' framework, for example the IBM Watson project. This system was specifically designed to answer questions it had never seen before. It does this as a part of a general knowledge quiz game, titled Jeopardy. The questions are enriched with language tricks and jokes. It is well known that Watson won the Jeopardy championship in 2011 against former human champions (TEK was published in 2010, so unfortunately the analysis of this case could not be included) The game was played in English, so one might ask whether this means that the capability of understanding language was transferred to a machine. An even more interesting scenario is a similar situation of the "beer-mat" knowledge (TEK:59). This case is about a man who reads a short text about holograms from the back of a beer mat. It does not allow him to build a hologram, but he could answer questions about holograms, such as, "Do holograms include lasers?"

Watson was trained on mostly Wikipedia pages that are similar to the back of a beer-mat. Yet, not all the possible questions of Jeopardy were programmed into it, and it still won. Does this mean that Watson reproduced the man with the beer mat and the language skill that comes from socialization? In other words, was the act of programming Watson some kind of limited socialization?

Collins' answer would probably be "no". Maybe he would argue that this is a typical case of a so-called polimorphic action that turned out to be reproducible by mimeomorphic actions (read: can be carried out by a Chinese room), just like playing chess. This way, playing Jeopardy became explicated, but it is not the same as the knowledge of using language. However, this also means that this game cannot be seen as a real social situation anymore. In Lowney's opinion, Collins' effort helps us to remember what makes us different from machines. I am afraid of the opposite possibility: as the front line of explication progresses in this system, the set of things that make us unique is continuously shrinking. We can only hope or expect (as Collins does) that one day, this front line will simply stop, but as long as the expansion of the explicit continues, any human activities that are reproduced will be devaluated.

Anyhow, it is undeniable that Collins brought a brand new approach into the debate over tacit and explicit, and this approach came with its own metaphysics. *TEK* is a novel project that aims to solve a number of slippery questions, including the explicit, the tacit knowledge and the evaluation of AI, in a unique way.

3. Explicit Knowledge in Polanyi's Philosophy

Collins' complaint that explicit knowledge does not have the backing of proper literature and a straightforward definition is by no means unfounded. For instance, in *Personal Knowledge*, Polanyi simply starts using the term "explicit" in a footnote yet does not include later in the book any definitions of this term. Meanwhile, Polanyi asserts that wholly explicit knowledge is "unthinkable". In order to understand this assertion, a proper definition would indeed be helpful.

I believe Polanyi's chapter titled "Articulation" offers the most important information about Polanyi's concept of explicit knowledge. From the introduction of this chapter, we learn that Polanyi feels it is evident that there is a huge gap between the intellectual capabilities of humans and animals. The use of language that is enabled by articulation creates this gap. Collins and Polanyi would agree on these overarching points. However, there are huge differences in the details of their theories. While Collins believes the most important element of language is the collective, Polanyi defines language as being the result of the articulation capability of the person, which also has a social aspect.

Polanyi explains the gap between animals and humans by telling the case of researchers who observed the parallel development of a chimpanzee baby and a human baby. In the initial stages of the subjects' lives, the researchers observed the human baby having no significant advantage over the chimpanzee baby. However, the human child's intellectual power apparently multiplied when he started using language, which Polanyi believes gave the child access to the cultural heritage of his ancestors (Polanyi 1962:70). In response to this study, Polanyi insists that the biological facilities that enable language are not dramatically different from those of the chimpanzee, so he sees no perplexing jump in evolution between the two species. Instead, he thinks that certain inarticulate facilities are already present in animals and that only the combined capability of these facilities is missing from the animals. The result of the right combination – the capability of articulation that is necessary for developing language skill – is what makes humans intellectually superior.

3.1. The degrees of pre-lingual intellect

Polanyi differentiates various intellectual capabilities by relating them to different concepts of learning, which he dubs Types A, B and C.

An example of type A learning is a rat that learns by chance how to obtain food by pressing a lever in a laboratory experiment. Given its desire for food, it will repeatedly press the lever after learning the effect of doing so. Polanyi calls this trick-learning, whereby the animal learns how to perform a particular operation.

Type B learning features signs that enable the animals to predict a certain future event or state. A rat is capable of learning that the boxes with a certain sign contain food. The instant the animal discovers the relevance of the sign, it no longer

bothers to open the boxes without the sign. In addition, Pavlov's dogs are capable of predicting food by noticing a sign (of course, the experiment is usually cited to show how unconditional a reaction can be).

Type C learning is latent learning. A rat is able to learn the shortest route in a maze after exploring it for some time. Even when the experimenters place an obstacle in this optimal route, the rat finds a good alternative route much more quickly than a trial-and-error method would allow. This means that the rat must have a mental representation of the maze that it can apply to an altered situation. The aim of these examples is to show the different stages in the development of representation.

3.2. Language

Humans are capable of even more than the latent learning in the previous example. The source of that ability, according to Polanyi, is the *certain way* humans create and manage mental representation. He calls the principles by which these processes work the Operational Principles of Language, because these principles result in the appearance of language when they function properly.

Humans are capable of effectively mapping the world to a relatively small set of elements. This capability is called the Law of Poverty, and Polanyi calls these elements *symbols*. However, a small number of elements is not sufficient for communication. Their mapping to the experience about the real world must also be *consistent*. Moreover, the combination of these symbols should not be arbitrary, because a certain *grammar* is needed.

The manipulation of the symbols should be rather effortless so that it falls under the Law of Manageability. This law must be in effect from the *primary denotation*, the *reorganization* and in the *reading of the result.*

Polanyi's theory holds that if symbols meet these conditions, then they will enable the skill of articulation, which, in this book, means the process of creating symbolic representation (Polanyi 1962:82-5). The skill of articulation and the skill of managing symbols are simply further developed versions of the animals' similar skills.

In his system, skill is one type of knowledge, and the potential for each skill is embedded in the human brain. As Polanyi puts it, tacit skills are cooperating with the explicit (Polanyi 1962:87). This statement makes clear what Polanyi considers *explicit*: the symbolic representation that is part of a language and that was created by articulation. Knowledge that cannot be articulated in terms of the symbols of a language is tacit. Not everything that is articulated meets the operational principles, so articulated and explicated are not always the same in Polanyi's framework.

If we are interested in assessing only the concept of explicit, it is not necessary to accept Polanyi's account of the emergence of language. Without that account, we can still summarize what he calls explicit: everything that is expressed in linguistic symbols. *Language* is inclusive here: it can be text, formalisms, characters, diagrams, charts, etc. (Polanyi 1962:78). Nor it is necessary to accept the operational principles, according to which pyramids are symbols but not parts of language because of the

pyramids' lack of manageability (Polanyi 1962:81). In this chapter, I will use the term *explication* in this sense, which contrasts strongly with Collins' concept of explicit.

According to Polanyi's theory, a person can never fully express her whole knowledge with symbols, because even her most formalized knowledge is still partly made of the facility of articulation as well as of consistent denotation of those symbols and the facility of managing them. These are not symbols, so they are not explicated. Yet an external observer (Polanyi's neurobiologist for instance – see later) can assign symbols to these facilities of the brain, and those symbols can be the explicit part of the observer's knowledge. But, this is knowledge *about* someone else's knowledge, not the external observer's own knowledge.

This is why Polanyi believes it is trivial that no one can explicate her own bicycle riding skill in human language. Even the question of the possibility of fully explicit knowledge only surfaces with the strongly formalized, propositional sentences, such as knowledge of Laplace's demon (Polanyi 1962:139-41) or logical sentences that are processed by computers. According to Polanyi, even these are not fully explicated as the symbols cannot include their own meaning that relies on the tacit facilities of consistent symbol denotation, etc. Even for understanding the most formalized sentences, a person is needed. As Laplace's demon has no personality it does not have real knowledge of the world, even though it explicitly knows the position and momentum of all particles of the universe.

By emphasizing the impossibility of knowledge without a person, Polanyi tries to call attention to how hopeless and even dangerous are those programmes that promote the ideal of the fully objective knowledge, like neo-positivism.

It is important to note that when Polanyi talks about inexplicability, he consistently means from the perspective of the knower. He sharply distinguishes inexplicability from another situation in which a scientist examines the processes unfolding within a subject while the subject is performing something (e.g., riding a bike) with his knowledge (*Polanyi* 1968:39). The scientist can see and describe those inner processes that are hidden from the subject's attention. This is explication, but not of the knowledge of the subject. This is an explication of the knowledge of the scientist (maybe the scientist cannot even ride a bike). Furthermore, this explication is only partial – the scientist cannot fully explicate everything he knows about the bicycle rider's skill.

The inexplicability of riding a bicycle in this framework only means that no one can learn to ride a bicycle by simply reading books about the activity. Performing the act is only possible by exercising balance, which builds the necessary facilities in the performer's neural system that cannot be made by receiving language sentences[4]. Now, there are other imaginable ways of riding a bicycle. For instance – as in Collins' example – one might learn to ride a bicycle on a low-gravity asteroid by

[4] For Polanyi, these are different kinds of changes, because the body and the symbols are on different ontological levels in his emergent ontology.

simply reading and interpreting some rules regarding the angle of the bike, the handlebars and so on. Learning about this type of activity would replace a certain kind of tacit-only knowledge with a more developed form of explicit+tacit knowledge that involves reading and interpreting, that is, inexplicable abilities that are present in only humans. Learning to ride on an asteroid this way would not engender full explication, as it involves tacit knowledge about reading and following instructions.

Polanyi developed this conceptual framework to show that the knowledge of the bicycle rider and the knowledge of the scientist share traits, no matter how formalized and symbolic the latter's knowledge is. That is, neither of them can eliminate their own person from the knowledge. At the same time, knowledge can be replicated in his system even though it cannot be explicated. One would replicate it through ostensive learning in the training of medics, riding exercise bikes, etc. Moreover, animals have knowledge, but they have no language, so everything they know is tacit[5].

Without going into further detail here, Polanyi explains that acquiring knowledge is always an act of belief. It cannot be a result of logical inference, because knowledge cannot be fully formalized in logical sentences in the first place. Therefore, the proposer of the knowledge must exhibit persuasive passion to compel the listener to jump the gap that cannot be bridged with logic alone.

Meanwhile, knowledge has truth value in Polanyi's philosophy, regardless of its inexplicability. This truth value is neither subjective nor objective. With the sub-title *Towards a Post-Critical Philosophy*, he wants to express that he is against objectivism as well as the relativism that criticizes objectivism. He believes both approaches are wrong and can even be dangerous[6]; instead of following those, he suggests following a third way that is now called the personalist or emergentist approach.[7]

4. Conclusions

As we can see, the notion of explicit and tacit largely differs between the philosophies of Collins and Polanyi. These authors offer independent, incompatible answers to more-or-less the same questions.

In Collins' system, the successful replication of knowledge by transferring strings means that knowledge has been explicated. At the same time, his position is that the knowledge that involves understanding language or other social relations cannot be explicated via string transfer. However, if there exists a string that makes something ride a bike, then bicycle riding would be explicated.

[5] In our previous paper, which we wrote with Daniel Paksi to the *Appraisal Journal (Héder and Paksi 2012)*, we also argue that certain machines are similar to animals *in this respect* (not in others).

[6] See his moral inversion concept (Polanyi 1962:233).

[7] It would be interesting to discover in detail the parallels between Polanyi's program and the program of the Third Wave of Science Studies.

In Polanyi's system, explication means expressing something in language, even though one cannot articulate any kind of knowledge fully. He believes communicating complete knowledge is completely impossible because every kind of knowledge is, in part, embodied in the person and that embodiment is metaphysically different from the signs of language and therefore cannot be articulated. Knowledge can be replicated, but replication is not explication.

We can conclude that Collins built a completely novel conceptual framework for tacit and explicit knowledge. One must accept Social Cartesianism to use Collins' theory[8]; otherwise, there would be no inexplicable knowledge, not even language skills. Knowledge that does not involve language can be explicated, and it is only a matter of time, effort, interests and logistics before they are explicated. In contrast, Polanyi simplifies tacit and explicit knowledge. Everything that is represented in language is explicit, but language always conveys less than what we know. Therefore, explication in Polanyi's theory is always incomplete.

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[8] This fact is openly admitted by Collins in TEK:164-5.

SYMBOLS, STRINGS AND SOCIAL CARTESIANISM: RESPONSE TO MIHÁLY HÉDER

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ABSTRACT

I respond to Héder's analytical critique of *Tacit and Explicit Knowledge*. Héder concentrates on the first part of the book – the way the idea of strings is used to clarify the notion of explicit knowledge. I find his critique encourages me to think there may be more to the idea of strings than just a foundation for the second part of the book; the notion of explicit knowledge really does need much more careful analysis and it should not be confounded by the mixed-up notion of 'symbols'. Unfortunately, Héder does not always distinguish between different levels of philosophical analysis: the skilled philosopher can doubt anything and everything but if we are to use philosophy to clarify things of substance we must narrow the critique and take most of the world for granted – we must be parsimonious about what we choose what to make strange. Illuminatingly, Héder show that some of my distinctions between conditions of communication are not what I thought they were. The distinction between enabling communication with longer strings and with the addition of hardware is not as clear as I thought it was. Indeed, when it comes to computers, the same string enhancement can be accomplished sometimes with hardware and sometimes with software. My solution to this problem is to refer back to general usage within the form-of-life of the transmitters of strings. I thought I was ignoring transmitters in my analysis but it turns out I need them. I thoroughly disagree with Héder's invocation of a new ontological entity, the 'pattern processing system'. Computers should be thought of as continuous with cause and effect in the natural world whereas human knowledge depends on language which computers do not possess. There are only two kinds of entities, those that can accomplish polimorphic actions and those that cannot.

Keywords: explicit knowledge; tacit knowledge; strings; symbols; ontology; polimorphic actions.

1. Introduction: The two halves of TEK

'[I]t is undeniable that Collins brought a brand new approach into the debate over tacit and explicit.' (Héder 2012:53) Truly one is lucky to have such generous critics and I thank Mihály Héder for considering my book Tacit and Explicit Knowledge (TEK) so carefully and provocatively. There are a number of points in his comments that have led me to think about things in new ways. There are some others that I

don't quite understand, the problem exacerbated by his tendency to ask questions and then answer them himself. There are also some criticisms that seem wrong. The balance is very much on the side of the positive and constructive.

My first paper discussing tacit knowledge was published in 1974 and I have been writing about it, on and off, ever since. When I set out to write TEK my idea was that I would draw everything I knew about tacit knowledge together in one place. I thought it would take me about four weeks to write the first draft. But what happened is that I found I could not write the book without starting with explicit knowledge and I found I did not understand explicit knowledge. That is why there are two halves to the book, the first dealing with explicit knowledge and the second with tacit knowledge. The first draft of the book took me two years to write rather than four weeks and the majority of that time I was working on the first half. But I still feel that the first half is raw, insecure and incomplete. The more I think about explicit knowledge the more remarkable and mysterious does it seem and this puzzlement has continued to grow since the book was published: Here is a person A, who cannot do some task X. A person B then causes A to be impacted by something physical – let us say some air vibrations. The air vibrations have no obvious causal connection with X – X is one thing, air vibrations are something completely different. But after the impact A can do X. That's weird!

The rawness and incompleteness did not worry me too much when I finally finished writing TEK. As far as I was concerned, the point of the first part of TEK was to find ways of talking about the explicit that would make it possible to set out the second half – the three-way classification of tacit knowledge. I saw the first part as a ground clearing exercise that would make the space for the second part. I knew that the first part might be doing little more than displaying my ignorance and reviewers might tell me that the meaning of explicit had been better dealt with by earlier thinkers but even if that happened I was content that the first part had done its job of setting up the second part. Time is drifting by, however, and I still do not know where else to look to find the resolution of the problem of explicit knowledge. I am beginning to wonder if the 'string' business is worth something in itself. So it is nice that Héder (2012) chooses to concentrate on explicit rather than the tacit knowledge aspect of TEK and especially nice that he says the approach is original.

2. Polanyi and strings

I will begin with Héder's contrast between TEK and Polanyi's *Personal Knowledge* (PK) which seems to me to be apt and which takes us straight to strings. Thus, I will develop a little further something that appears in TEK as little more than a footnote. Following Héder, it seems that TEK and PK deal with two different problems. TEK deals with the nature of knowledge, PK deals with the nature of *human*

knowledge. The difference arises, perhaps (something suggested in TEK), because of the explosion in artificial intelligence that characterised the second half of the Twentieth Century. As a sociologist of knowledge I found the 'hype' surrounding artificial intelligence could not be escaped and I found myself writing two books critiquing it (Collins 1990; 1998). Subsequently, for me, central to the problem of understanding knowledge, is the contrast between what machines can do and what humans can do.[1] I am guessing that this was not a central concern for Polanyi and that is why he concentrated on humans rather than on knowledge.

If you are primarily interested in humans it is reasonable to ask how much of their knowledge can be captured in *symbols*. It is an empirical question – you can look around and see how much is being done with symbols and how much is not being done with symbols. But, if you are interested in knowledge, that is a bad place from which to start. The reason is that the term 'symbol', and its bedfellows, 'sign', 'icon', etc., have a strong element of circularity. A 'symbol' is something that carries meaning to humans. We already know that if we are dealing with symbols they are meaningful. That's why Polanyians are always having to point out that the meaning of symbols is not provided by other symbols. Meaningfulness is unaccountable: it is tacit and that is why explicit knowledge – symbols – rest on tacit knowledge. But the same symbol is not a symbol when offered up to a machine – machines do not deal in meaning. So machines have to be dealt with quite differently to humans if you start with symbols.

It seems to me that starting with strings sweeps away many of these confusions. Sometimes a string is a symbol and sometimes it is not. The question then becomes clear – when is a symbol a symbol and when it is it not a symbol and only a string? And what can strings do when you present them to humans and machines. It becomes immediately obvious, for example, that sometimes the same string can act on a human in the way a string acts on a machine – which is what nearly everyone misses – and sometimes it can act as a symbol – something with meaning. The difference is worked out on page 17-18 of TEK with the example of the sergeant-major. This kind of thing is just a mess if you start with symbols.

Furthermore, the mysteriousness of the efficacy of strings on humans when they act in a meaningful way is much more striking than the efficacy of symbols because symbols are already efficacious by definition. More and more, it seems to me to be correct that if you want to deal with knowledge and its transmission without getting mixed up, it is best to start with strings. That may be the most important contribution of the first half of TEK.

[1] This is very much in the tradition of Hubert Dreyfus (e.g. 1972) though nowadays he and I have diverged markedly (e.g. Selinger et. all 2007). This is especially notable in respect of the relationship of language and practice but also in the sociological rather than individualistic approach.

3. Choosing what to make strange

The thing that strings do for you is render the familiar strange. I am not a trained philosopher so this is hubris, but I think that making the familiar strange is the fundamental move in all of philosophy. Symbols do not seem strange – we use them all the time – but when we notice that transmitting a symbol is 'really' transferring a string then we notice what a strange thing is going on.[2] I would like to think this kind of thing is analogous to Hume noticing how strange it is to reason from induction; I would like to think that the superficial but 'soothing' resolution provided by the notion of cause is analogous to the superficial but soothing resolution provided by the notion of symbol. In both cases the word helps us not notice that something very odd is going on.

As a sociologist I have tried to show that the problem of induction presents itself in the day-to-day practice of scientific discovery: how do scientists get to conclude that certain experimental results are regularly repeatable and others are not? Likewise with strings: for the sociologist, rendering explicit knowledge strange is not the end point but the starting point for questions about how knowledge and abilities are transferred in day-to-day life.

I think you have to choose what things to be puzzled about and what not to be puzzled about given that the skilled philosopher can, or ought to be able to, make anything seem puzzling. Héder has demonstrated a lot of skill in making things puzzling. The trouble is that some of the puzzles he poses are of a very general nature – general problems of philosophy – rather than puzzles that relate to the particular problem of tacit and explicit knowledge. For example, consider his question about whether adding computer chips to a plastic plate is giving new abilities to the plate. This is a good philosophical question but one which refers to the general problem of the identity of things, not the problems dealt with by TEK. For example, imagine I am at the Hungaroring talking to a McLaren engineer. He says 'I tune the engine to make the car go as fast as possible'. Lewis Hamilton walks past and says 'no, you tune the engine to make *me* go as fast as possible.' I say 'no, you tune the engine to make that speck of dirt on the exhaust pipe go as fast as possible'. Exactly what the engineer is doing is a philosophical problem which might lead on to talk of actions and intentions or might lead us back to Plato and the cave, and so on, but it isn't one we are going to solve here in any new or decisive way.

What Héder has caused me to see is that when I say the following on page 16 of TEK: "…strings are entities and entities are strings, so what a string is and what an entity is depends on what is going on at the time." And "…strings are just entities. In the actual analysis, the meaning of terms should emerge from the context without

[2] Consider not only the strangeness of strings being able to transfer abilities but also the estrangement of phrases like 'this is a photograph of Ludwig Wittgenstein' etc. (TEK:39 ff).

difficulty." I should have been more technical and said that I was taking a certain philosophical position. This is that the problems associated with how we cut up the buzzing, blooming confusion of the world into objects – why we can have tables that are sometimes tree stumps, and chairs that are also sometimes tree stumps, and why we have green and blue instead of grue and bleen – is taken to be resolved by some combination of Goodman's idea of linguistically entrenched projections and Wittgenstein notion of form-of-life.[3] In other words, I start with a commonsense notion of the world given by the essentially sociological notion of form-of-life – which is, I believe, the best we can do when it comes to talking about the way we cut things up into nameable entities. Under this model, for which the icon might be Wittgenstein's discussion of the meaning of 'game', meanings are not given by sharp edged definitions, they are given by the way we generally see things as a result of our socialisation. It is also the case that what part of our socialisation is drawn on varies from context to context. From within that taken-for-granted reality one estranges oneself from particular features of the world in order to ask specific kinds of question about how we cut things up in respect of certain specific entities; you cannot ask all the questions at once.

4. Communication and Inscription

The danger with the commonsense approach I have just described is that it can be used as an excuse for lazy thinking. To avoid it one must be ready to see a problem if it really does affect the main argument. Héder has certainly pointed out something to me that I simply had not noticed. This is that it is hard to draw a dividing line between condition 3 and condition 4 of communication. I would not care very much if there were just a few borderline ambiguities – 'that is life' – or I should say 'that is forms-of-life' – but the problem seems to go deeper. Thus, condition 4 of communication involves a physical change in an entity in order to create the conditions of communication whereas condition 3 involves the enhancement of a string. Héder points out that in my examples condition 4 comprises plugging a new memory chip into a computer while condition 3 comprises sending a string which is enhanced by the addition of a new computer program. But as he says, the new computer program will effect a physical change in the computer's hard disk so both conditions involve physical change. Indeed, he goes on to suggest, though a little less convincingly, that condition 1 and 2 also involve physical changes in the entity that is impacted by the string. From this he argues that there is no real distinction between the first four conditions since all involve changes to the recipient and, at

[3] I discuss the problem at length, drawing on Goodman and Wittgenstein, in Chapter 1 of Collins 1985.

best, it is a matter of degree. He even argues, though much less convincingly, that the process of socialisation that leads to condition 5 is no different to the other conditions because it can be imagined as an elaborate process of string transmissions that lead to a change in the receiving entity (we do not need to worry about this since he goes on to agree that this would not really be socialisation).[4]

5. Ontological fishing

Now, as far as I can understand, Héder has a reason beyond sheer analytical curiosity for wanting to reveal these overlaps between the categories. The reason is that he wants to introduce a thing called a 'pattern processing system' – a computer – as a distinctive ontological feature of the world. He says that if we introduce this third kind of thing we can solve my problem of overlap. We might say he is dangling his favourite ontology in front of me in the hope that I will snap it up as the only way to resolve the problems he has uncovered in my schema:

> If we do not assume the premises that a) P is a pattern processing system, b) the boundaries of the system are clear, c) its embodiment's structure is separable from its dynamically changing state; then we do not have any means to explain the difference between conditions 1-4, because they would differ in only the extent of the change. (Héder 2012:51)

I am not, however, going to take the bait. I have a positive reason for not taking it as I will explain shortly. But, in any case, I am not that hungry. I already have solution to the problem – forms-of-life. I think, however, that I am being a bit more than lazy-minded here because I have spent a long time thinking about this example and have realised something new about TEK as a result. What Héder has made me see is that a set of actors which I thought I had excluded from TEK plays a central role in the book. I say on page 15 of TEK:

> Another unusual feature of the analysis is that very little attention is paid to transmitting entities; nearly all the work of analysis concerns strings and their impact on things with the producers of strings being part of the background.

On page 28 I say:

> In 'telling' the attempt is made to represent lived meaning with the inscribed string. For example, in the case of conversation an attempt is made to represent the meaning

[4] I will concentrate on conditions 3 and 4 as that is the most striking example of his point.

> as a string comprising vibrations in the air. This book does not deal with the teller or transmitter of a string.

But now I see that the transmitter is already there throughout the book in a latent form and even explicit form as we reach the end of the first half:

> We don't count enabling conditions 4 and 5 of communication as "rendering explicable," because they comprise changes in the receiving entity rather than changes in the string. That is to say, even though a string that initially cannot do work can be made to do work by physical changes in the entity upon which it impacts, we do not say that these changes render the string explicit: *this is just how we use words*. (TEK:81, stress added)

Maybe it would have been better if this had been made clearer. It is the transmitter, drawing on the transmitter's form-of-life, who determines what it is that amounts to a string transmission, what amounts to string enhancement and what amounts to making a physical change to the receiver. That's the general point.

We can, perhaps, narrow it down a bit further. When the transmitter is 'enhancing a string', the intention is to execute one specific communication – the particular multiplication or, to refer to my other example, the particular joke that is being told in the pub. When the transmitter is 'effecting a physical change in the receiver', there is some more widespread increase in capacity is in mind. It may be that the extra inscription on the hard drive increases the computer's capacity to multiply in general but that was not what the transmitter had in mind even though the philosopher can correctly point out that multiplying ability has been improved. The pub joke example is clearer I think – I do not see what general capacity is improved by telling one joke at full length. So it turns out that I am relying on the transmitter's sense of things in spite of the fact that I said in the book that it did not deal with transmitters.

We can put it this way: the analyst can make out that there is overlap between the condition of communication because all involve what can be construed as string transmission (after all strings are entities and entities are strings so a memory chip can be construed as a string), and all involve what can be construed as change in the receiver if we count things like new hard-drive inscriptions as physical change: this is the penalty of my flat ontology. But the actors who do the transmitting do not look at it this way: they know when they are transmitting a particular string, when they are enhancing a particular string and when they are physically changing some entity by adding another entity to it in order to make it possible for strings to act more efficaciously now and in the future.

It is also rather like this: an analyst like Goodman can point out that there is just as much warrant for claiming grass is grue as for claiming grass is green but no-one other than philosophers have any doubt about the matter. The string equivalent of

green is good enough for the first half of TEK where we are trying to work out what we mean by explication. Furthermore, if the form-of-life were to change so that adding a chip to a computer became thought of as part of an act of communication, I don't think it would make any deep difference; explication would still consist of the same set of things though they would not divide up in quite the same way. But the exact way they divide up does not matter so long as the same overall set of acts amounts to explication. In other words, in respect of explication, the way the world cuts up does not matter except in so far as we are trying to create a correct description of the world of the actors – the world we live in.

And this had better be right! Héder says at one point that I make, and need, a sharp distinction between hardware and software – and I now see that such a distinction is there in various passages in the book. But if I really needed that distinction to be an ontological feature of the world I would be in deep trouble. I wrote my first 'computer program' in 1968 or 1969 and at that time to do a multiplication one had to repeat a series of additions into a specific memory location – in other words, just to multiply one had to write a long string. BASIC was a huge advance in my computing life because that long string was now embedded in hardware (or is it pre-loaded software?), meaning I had only to write a short string. So any distinction between hardware and software is not going to last long in an ontological sense and the 'same thing' that was once done with a long string can now be done with a short string plus hardware. But the computer user still knows when they are writing enhanced software and when they are adding, or buying, better hardware – it is just that the boundary keeps shifting. So the ontology cannot matter even though we can still build a classification of kinds of explication which turns on commonsense categories.

6. Social Cartesianism and the ontology of TEK

Where the ontology does matter is when we get to Social Cartesianism. Social Cartesianism is an analyst's category not an actors' category – it is *my* analyst's category. For some reason Héder seems to think that Social Cartesianism is a matter of *belief* – as though I had plucked it out of the air to suit my specific purpose in TEK.

> It is interesting that accepting this dualism is not a logical necessity but rather a matter of belief, the faith of which is a "hostage of fortune" (TEK:144). Collins allows that at some point – although it is not yet imaginable how – someone will be able to construct a machine that is able to use language. It remains unclear whether this would mean that Social Cartesianism is wrong or that machines are also able to access the world of language after all. (Héder 2012:51)

But though the term, 'Social Cartesianism', was introduced only in TEK, the idea that 'the social' is a fundamental constituent of the world and the consequent dualist ontology has been central to much of my work.[5] I was also surprised to find Héder saying that TEK was unclear about the consequences of the invention of a machine that could cope with language in a human-like way.[6]

For me, then, there are language-speaking humans and there is everything else. What positive reason do I have for not embracing the third ontological category that Héder desires to bring in – pattern-processing systems? It is because I want to establish the ontological continuity between string transmission and transformation and physical cause and effect. The bridging device I use is the analogue computer. Analogue computers are just sets of causes and effects.

> Computers, of course, merge into the world of machines in general. Imagine I am driving a backhoe (or JCB). I move a little lever with my fingertips and through a series of analogues (for example, movement of cylinders and flows of hydraulic fluids), a much larger arm and bucket moves. [...] The backhoe is just an analogue computer being used for something other than computing. To summarize, string transformations and mechanical causes and effects are, to speak metaphysically, just two aspects of the same thing. (TEK:50)

I think this continuity is central to understanding analogue strings and, at this point, I cannot imagine abandoning it.

[5] For example it is central to the argument of both Artificial Experts and The Shape of Actions (op cit note 1) and it is the very topic of Collins, H. M., (1998) `Socialness and the Undersocialised Conception of Society', Science, Technology and Human Values, 23, 4, 494-516. Oddly in his footnote 3, Mihály cites this later work and agrees that the ideas were already central to my work.

[6] On page 89 of TEK a table of meanings of 'cannot' introduced and the following pages of discussion are all aimed at explaining what is meant by this and related claims. I doubt if anyone has ever been clearer about what they mean by 'cannot' and what the consequences are of a 'cannot' claim being proved wrong. For non readers of TEK, so long as no-one invents a way of making machines that can handle language in the way that humans handle it – something which is 'literally' unforeseeable – then Social Cartesianism holds. As I explain, I am not a prophet and it may be that such a thing will be invented, or introduced to us by aliens from another planet, in the way that faster than light travel after the fashion of Star Trek may one day be within our grasp. If the language equivalent of 'warp speed' comes about then Social Cartesianism will no longer hold and much of what I have written about the relationship of humans and machines would have to be rethought: I have set out the conditions under which my argument would be falsified – in good Popperian fashion. For the time being, however, the argument does not have to be rethought. Uncharacteristically, Mihály has failed to take notice these pages of discussion that deal specifically and at length with something he says is unclear.

7. Other points

Héder suggests that I might change my mind about artificial intelligence if I were forced to consider the success of a computer in the game of 'Jeopardy'. But then he goes on to explain, exactly and correctly, how I would deal with it. The answer is immanent in The Shape of Actions (op cit note 1) and does involve the substitution of polimorphic with mimeomorphic actions, just as he says.

Mihály complains that TEK does not

> explain how the first irreducible society materialised. This lack of an origin story in his text raises a number of questions. If the world of language did not exist in pre-human ages, then when did humans create it? Moreover, collectives, subcultures and languages continue to develop today. How many worlds of meaningful languages are there? How many people must speak a language to make it meaningful? Can we observe the jump through the metaphysical gap? (Héder 2012:52)

One small book cannot deal with all of this but there are some snippets in the extended work of myself and others. But, as for how the first languages arose, in a paper entitled 'Building an Antenna for Tacit Knowledge' that is due to introduce a forthcoming special issue of *Philosophia Scientiae* devoted to TEK, I suggest that the best we can do at the moment is imagine it as caused by something like the appearance the mysterious black obelisk visualised in Stanley Kubrick's *2001*. There is a wonderful puzzle there for someone to solve but it is unlikely to be me. How big does a society have to be to support a language? I have inquired of linguisticians and found that their studies show that as societies become smaller their languages become simpler but I do not think anyone has investigated the cut-off point or exactly what would constitute the cut-off point. I have also discussed the matter with my philosopher colleague Martin Kusch and we agree that Wittgenstein's 'private language argument' does not do the job. This is another wonderful topic. How many worlds of meaningful language are there? Among other works, my, 2011 `Language and Practice' discusses the question in terms of the fractal model. As for languages which continue to develop today, *Changing Order* (op cit note 4), investigates that problem by looking at how scientists develop new concepts – which is, of course, a matter of developing new languages.

8. Conclusion

Héder has given a lot of thought to TEK and made me re-think certain things and see them more clearly. I had not noticed that, when thought about in terms of the physical make-up of the devices, condition 3 involved a change in the receiver of a

similar order to condition 4. I did not realise the extent to which I was invoking, and needed to invoke, the sender in order to maintain the difference between conditions 3 and 4. This difference is maintained by invoking actors' categories – or commonsense meanings within a form-of-life: actors' ways of being in the world establish when they are transmitting a string and when they are changing an entity. Though 'context' is invoked in TEK (16) for deciding between the string usage and the entity usage I had not realised that the role of forms-of-life and Wittgensteinian philosophy was a bit more central to my account than I thought it was – Héder's criticisms have brought this out. In contrast one can see the extent to which Social Cartesianism is an analyst's category.

In spite of Héder's criticisms, given this re-thinking, I believe the ontology of TEK is both valuable and correct. There is a flat ontology for strings and entities – they are continuous with one another, just as hardware and software are continuous, which means that, ontologically speaking, string transformation and physical cause and effect are the same. As I say somewhat wistfully:

> …if all the work that is today done with computers was done with elaborate versions of Charles Babbage's Difference Engine, with its clunking gears and ratchets—and it is only logistics that prevents it being so—it would be much easier to understand that a computer is a physical mechanism. (TEK:28-9)

This means that analogue strings and analogue computers can be understood whereas if computers were added as an ontologically distinct category one would, I believe, find all this getting mixed up.

There is, however, a sharp discontinuity between the physical world on the one hand and humans and their languages on the other. Having been forced to think about it, what is going in TEK is that the ontologically mixed-up category of symbols has been rejected for the flat ontology of strings while the hidden ontological function of symbols has been reintroduced in the clear distinction between non-humans and humans. This difference is also expressed in the distinction between physical effect plus strings versus meaning plus language. Héder's discussion, and the contrast with Polanyi that he brings out, intimate, then, that the idea of strings might serve a more important role in the understanding of explicit knowledge than that of merely opening a space for the discussion of tacit knowledge found in the second half of the book. Once more, I thank Héder for this most interesting and provoking discussion of TEK.

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MICHAEL POLANYI ON IMPLICIT BELIEF SYSTEMS, STABILITY AND TRUTH

Comments on a topic in Chapter 9 and 10 of *Personal Knowledge*[1]

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ABSTRACT

In this paper I try to analyse and comment on a very important point put forward by M. Polanyi in his *chef d'oevre*. In Ch.9 of *Personal Knowledge* Polanyi deals with the problem of implicit belief systems and their aspects of stability. He brings up the Azande belief system as an example of such an implicit system of beliefs. Then he specifies the three aspects of stability exemplified by it. He also brings up examples from modern science to show that the Azande belief system and the modern scientific belief system have and use the same three principles of stability. And thus these principles ensure coherence of the systems and not their respective truth. A much stronger assumption of Polanyi is that there are no principles of doubt that would show which one of the rival belief systems is true and which is false. I will try to discuss and dissolve the problem, namely: on what grounds do we have and what Polanyi does to disqualify the Azande belief system as wrong and the beliefs as mere superstitions.

Keywords: implicit beliefs, belief systems, truth, falsity, justification, stability, coherence of beliefs.

In Chapter 9 of *Personal Knowledge* (PK) Polanyi deals with the problem of implicit belief systems and their aspects of stability. He brings up the Azande belief system[2] as an example of such an implicit system of beliefs. Then he specifies the *three aspects of stability* exemplified by it. He describes those particular procedures and methods by which the Azande protect their belief system against the impacts of external criticism and adverse evidence. As Polanyi writes:

[1] The preparing of this paper was supported by the project TÁMOP-3.1.1.B-10/1-2010-0009 and by OTKA 72598.

[2] Described by Evans-Prichard in his *Witchcraft, Oracles and Magic among the Azande,* Oxford 1937.

> The stability of Zande beliefs is due, in the first place, to the fact that objections to them can be met one by one. This power of a system of implicit beliefs to defeat valid objections one by one, is due to the *circularity* of such systems. [...] A second aspect of stability arises from an automatic expansion of the circle in which an interpretative system operates. It readily supplies elaborations of the system which will cover almost any conceivable eventuality, however embarrassing this may appear at first sight. Scientific theories which possess this self-expanding capacity are sometimes described as *epicyclical* [...] The stability of Zande beliefs is manifested, thirdly, in the way it denies to any rival conceptions the ground in which it might take root. [...] This third defense mechanism of implicit beliefs may be called the principle of *suppressed nucleation.* (Polanyi 1962:288-91, italics MF)

Polanyi then brings up examples from modern (to him contemporary) science to show that Azande belief systems and modern scientific systems have and use the *same three principles of stability*. (Circularity, epicyclicality, suppression of nucleation). But – as Polanyi points out – these principles of stability ensure *coherence* and not truth. A much stronger assumption of Polanyi is that there are no principles of doubt that would show which one of the rival implicit belief systems is right or which is wrong, true or false. (Polanyi 1962:294) As he writes:

> I conclude that what earlier philosophers have alluded to by speaking coherence as a criterion of truth is only a criterion of *stability*. It may equally stabilize an erroneous or a true view of the universe. The attribution of truth to any particular stable alternative is a fiduciary act which cannot be analysed in non-committal terms. (Polanyi 1962:294)

There is no principle for discovering who is right and who is wrong when defending his/her own implicit belief system, that is: one's own commitment. (Ibid.) And that:

> Our formally declared beliefs can be held to be true in the last resort only because of our logically anterior acceptance of a particular set of terms, from which all our references to reality are constructed. (Polanyi 1962:287)

Nevertheless Polanyi concludes near the end of section 10 of the 9th chapter of PK that:

> The process of selecting facts for our attention is indeed the same in science as among the Azande; but I believe that science is often right in its application of it, while Azande are quite wrong when using it for protecting their *superstitions*. (Polanyi 1962:294, italics MF)

In what sense, then, are the Azande „wrong" and their beliefs mere „superstitions"? On what ground and in what sense can Polanyi disqualify Azande beliefs as mere superstitions? His answer runs as follows:

> [What] I reject ... as superstition, fatuity, extravagance, madness, or mere twaddle, is determined by my own interpretative framework. And different systems of acknowledged competence are separated by a *logical gap*, across which they threaten each other by their persuasive passions. They are *contesting each other's mental existence*. (Polanyi 1962:318-19; italics MF)

Thus for Polanyi, truth or falsity can be decided only *within* a system of beliefs (or conceptual system), the systems themselves are accepted or rejected by those who are committed to them or against them. The *logical gap* separating the systems, does not allow for a logical decision algorithm between them.

This is why according to Polanyi belief and doubt are equivalent. (Polanyi 1962:Ch.9,§2) Both involve personal commitment, a fiduciary act which is *ineliminable* and unjustifiable, because justification (by evidence or inference) exists only *within* the system, the stability and credibility[3] of which are sustained by commitment and maintained by the principles of stability used by the believers. The belief-systems or conceptual schemes can not be justified or falsified for (and by) those who accept or reject them.[4] This is why a Zande-type assertion, like "S. is a witch" is not simply false for a 20th century scientist but more than that: a superstition, a crazy assertion, twaddle, something which *can not* be true (nor incidentally) false, like, say: "George Washington was the king of France" or "Water is NaCl".)[5] These types of sentences, like "S. is a witch" can neither be true nor false. They are simply manifestations of a mentality foreign to us and unacceptable as candidates for being true or false. Unlike the statement "Water is NaCl" for the assessment of the truth-value of which we have a standard decision procedure, the assertion "S. is a witch" is rationally undecidable for us as far as its truth-value is concerned. It can only be rejected as nonsense, since there exists no methodological procedure to decide whether somebody is a witch or not. Because the concept of "witch" is (not simply missing but) excluded from our conceptual system. (It is not merely extensionally or incidentally void, like the notion of the "actual king of France", but also intensionally so.) We do not believe in the existence of witches, we are not committed to a system containing such a belief.

As Polanyi writes:

[3] There is a parallel point in the SSK-type sociology of knowlege. As Barnes and Bloor write: "It is not that all beliefs are equally true or equally false, but that regardless of truth and falsity, the fact of their credibility is to be seen as equally problematic." (1982:23)

[4] And as it was shown by Quine they are underdetermined by observational experience. And thus by "nature" in itself.

[5] This conception is very similar to Hacking's notion of „styles of reasoning". According to Hacking, a style of reasoning is characterized not by what is true and what is false in them, but rather by what is/can be true-or-false.
Cf. I. Hacking 1982.

> According to the logic of commitment, *truth is something that can be thought of only by believing it.* It is then improper to speak of another person's mental operation as leading to a true proposition in any other sense than that it leads him to something the speaker himself believes to be true. (Polanyi 1962:305)

He then emphasizes that it is *illegitimate* (not simply wrong) to speak about some proposition as true in itself. (Ibid.) Truth without a believer is nonsense.

But what is this commitment, this fiduciary act which determines acceptance and rejection, belief or doubt? Is it a mere act of faith, a mere arbitrary decision, a mere irrational accident? The fiduciary act is not an irrational decision in Polanyi's view – I think – though it is not rational in the sense of the rationality internal to a given system itself. As Polanyi writes:

> The enactment of commitment consists in self-compulsion with universal intent through the interaction of two levels: a higher self, which claims to be more judicious, taking control over a less judicious lower self. (Polanyi 1962:318)

Universal intent – I think – means bearing responsibility for accepting a belief item as a knowledge-claim, putting forward a particular belief as true within a system of beliefs and by that extending and strengthening (not destabilizing) a belief system itself. *Responsibility* is an essentially moral concept, and part of the notion of personality. Commitment to a system of beliefs is really part of one's personality, thus any belief taken to be knowledge is personal knowledge. To be committed to a belief or to a whole system of belief involves responsibility. And to be morally responsible involves to be open to moral assessment or to the judgment of others (the members of one's community) on account of that belief. The commitment means to be responsible for others and for oneself.[6]

But a belief *system* – in Polanyi's sense – is produced, maintained, stabilized and accepted by a given community, that is, by e.g. a scientific or else, by a tribal community, like the Zande people. A *system* of belief belongs to a community, not to any single individual. The individuals may – in different ways and to different extent – *share* the system of beliefs[7], that conceptual framework which they acquire during their process of socialization. But the epistemic 'owner' of a system of beliefs is

[6] As was argued by P. Hieronymi (2008), one can bear responsibility even for involuntary beliefs. "It turns out, that failing to be voluntary, beliefs are a central example of the sort of thing for which we are most fundamentally responsible." (2008:361)

[7] H. Collins, who has introduced the notion of 'collective tacit knowledge' besides of the explicit one, writes that „...the individual is not the unit of analysis: the individual merely shares the collectivity's knowledge. The special thing about humans is their ability to feast on the cultural blood of the collectivity. [...] We are, in short, parasites, and the one thing about the human brains that we can be sure is special, is the way they afford parasitism in the matter of socially located knowledge." (2010:131)

a community, not an individual person (or a number of independent, detached individuals). A 'private belief system' if it remains completely subjective and idiosyncratic, would be considered as a simple individual system of delusion, a manifestation of madness. On the other hand, if a system of beliefs is accepted by a community but the individual knower, the knowing person is not committed to it or tries to detach him/herself (by withdrawing his/her personal commitment) from it, the person's knowledge-claims are considered (by positivist philosophers) to be completely *objective*. But this is according to Polanyi like a truth without a believer, or an unsigned cheque – mentioned in the above quotation.

> For if the active participation of the philosopher in meaning what he says is regarded by it as a defect which precludes the achievement of objective validity, it must reject itself by these standards [...] While impersonal meaning is self-contradictory, the justification is self-justifying, if only it admits its own personal character. (Polanyi 1962:253)

But if both the personal commitment and the universal intention (the recommendation for acceptance to the whole community) are granted on the part of the knower, then his/her knowledge claim, is *personal knowledge* in Polanyi's sense. Universal intent, namely, is the intention to recommend the knowledge-claim, the particular personal belief, for universal acceptance, for inclusion into the communal system of beliefs as a true belief on the part of the knower. As for the concept of the 'personal' as distinct from both the objective and subjective knowledge, let me quote again Polanyi:

> I think, we may distinguish between the personal in us, which actively enters into our commitments, and our subjective states, in which we merely endure our feelings. This distinction establishes the conception of the *personal*, which is neither subjective nor objective. In do far as the personal submits to the requirements acknowledged by itself as independent of itself, it is not subjective; but in so far as it is an action guided by individual passions, it is not objective either. It transcends the disjunction between subjective and objective."(Polanyi 1962:300)

And as he adds to this elsewhere:

> It is the act of commitment in its full structure that saves personal knowledge from being merely subjective. Intellectual commitment is a responsible decision, in submission to the compelling claims of what in good conscience I conceive to be true. (Polanyi 1962:65)

There is, however, a question left to be answered for Polanyi. Namely: can systems of beliefs themselves be wrong? Or right? Can the notion of 'true/false' be applied

to them? When Polanyi deals with the role of education as a process of internalizing a system of belief of one's own community, he writes:

> In learning to speak, every child accepts a culture constructed on the premises of the traditional interpretation of the universe, *rooted in the idiom of the group* to which it was born and every intellectual effort of the educated mind will be made within this framework of reference. Man's whole intellectual life would be thrown away should the interpretative framework be wholly false; he is rational only to the extent to which the conceptions to which he is committed are true. The use of the word 'true' in the preceding sentence is part of a process of re-defining the meaning of truth, so as to make it truer in its own modified sense. (Polanyi 1962:112)

This is, however, not an answer to our former question. It points out nevertheless that it is impossible, on pain of loosing one's intellectual achievements and frame of reference, to reject a conceptual framework (rooted in the common idiom) as false from *within the framework.*

But is there any non-arbitrary, non-subjective ground to evaluate conceptual frameworks or systems of belief from *without, from the outside*?

The answer follows almost trivially from the above described Polanyian argument: rejection of frameworks/systems of belief other than ours is not only possible but inevitable. And since each of us is (must be as a human being) committed to one or other system of belief, which are separated by a *logical gap*, there is no way for a formal discussion based on a common ground and a proceeding according to a *common* logical algorithm. Thus, it seems, that Polanyi assumes a very serious kind of incommensurability[8] between and among the different systems of belief. So that the acceptance and rejection is a question of commitment, a fiduciary act, which as he admits is hazardous and may be erroneous. Is this the human predicament? Are all systems on a par, and is the choice among them a mere matter of chance?

I do not think, however, that Polanyi is a relativist. Even though he admits the cognitive fallibility of mankind. But he puts forward a very interesting argument which – I think – can save the cognitive value of even such a system as the Azande witch-beliefs. Let me quote this interesting argument which puts Polanyi's reconstruction of cognitive assessment into a wider perspective:

> Though a Zande witch-doctor arguing in terms of the poison-oracle is a clearly rational person, his rationality is altogether deluded. His intellectual system may gain a limited justification within a society which it supplies with a form of leadership and the means for deciding disputes, however unjustly. But as an interpretation of natural experience it is false. (Polanyi 1962:318)

[8] As it was pointed out by Struan Jacobs in his *Polanyi's Presagement of the Incommensurability Concept (2002)*

Now this is the point: systems of belief may serve different purposes and they have to be evaluated accordingly. The belief in the poison-oracle is not a knowledge claim about nature but a means of maintaining social order. And "witch" is *not a natural but a social kind.* The aim and use of the Azande system of belief is not the understanding and control of nature but that of the Zande society. The quest for comparison of the Azande and the modern scientific belief system according their truth value is thus meaningless. Since systems of belief may differ according to their aim and intention, not merely according to their truth value.

Summary

From the above argument, it follows that according to Polanyi belief *systems cannot be attributed truth values*, only *single beliefs* can be assessed as true or false *within* a given system. The belief systems may not be completely disjunct, there may be beliefs share by different systems, the truth value of which beliefs is the same even though the methods of justification are different in the different systems.

Another consequence is – I think – that there is no single linear scale along which we could order all spacio-temporally different human belief *systems according to their (moral, functional, cognitive or other) value.* The comparison of belief systems is a multi-parameter task, the result of which must accordingly be multi-dimensional (=non linear).

There is, however, a very important question, left untouched by Polanyi as well as in this paper so far. Namely: are there (can there be) internal principles for *de-stabilizing whole belief systems*, not merely some single, particular beliefs within it (like the original Popperian falsification principle of modern science.) Or: the de-stabilizing effects may come only from outside, like in the case of the Aristotelian system which was strongly de-stabilized during the 16th century by (among others) the impact of Hermetism, a conceptually and methodologically completely alien system of beliefs. The question is whether there are systems which contain a kind of feed-back mechanism for improving themselves in their cognitive and functional (or other) achievements. (In contrast to the Polanyian positive feed-back, this would be a negative feed-back). Is there thus, a possibility to compare belief-systems according to their self-correcting power, that is, according to the *aspects of in-stability?*

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TACIT KNOWING AND TACIT KNOWLEDGE FROM AN EVOLUTIONARY POINT OF VIEW

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ABSTRACT

The theory of tacit knowing plays a key role in the philosophy of Michael Polanyi, nevertheless it is not true that Polanyi deduces his theory of tacit knowledge from that. Tacit knowing is merely an example—but it is a very important example—of the working of tacit knowledge. So, our knowing is tacit because it is necessarily based on the previous tacit elements of our emergent hierarchy of knowledge. At the same time, if we accept, as Polanyi does, contrary to the commitments of modern philosophy, that the process of knowing is a social evolutionary development we can establish that our tacit knowing and knowledge are inseparably interwoven.

Keywords: tacit knowing, tacit knowledge, emergence, evolutionary epistemology, ontology, skills.

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Introduction

The theory of tacit knowing plays a key role in the philosophy of Michael Polanyi. The reason of this is twofold. Firstly, epistemology has already been in the focus of modern philosophy since Francis Bacon, and one of the fundamental goals of Polanyi's post-critical philosophy is the rethinking of modern epistemology. Secondly, tacit knowing may be Polanyi's most important example for the working of tacit knowledge.

Many who study Polanyi's philosophy, according to the commitments of modern philosophy, deal with his epistemology and lose his real goal; because Polanyi's primary intention is to talk about the *tacit* dimension and our personal *knowledge*. They assert that Polanyi's theory of tacit knowledge follows definitely from his epistemology, for example, as an aspect of his theory of tacit knowing. Contrary to this, I think that tacit knowing is merely Polanyi's most important example for the workings of our tacit knowledge, thus tacit knowledge can*not* be derived from tacit knowing.

If the theory of tacit knowledge followed from the theory of tacit knowing, then this would mean that Polanyi's ontology follows from his epistemology. The situation,

however, is *much more complicated*. It is true that in Polanyi's philosophy there are no objective and necessary ontological categories, but this is not the consequence of the diversity of individual (or social) knowing, but of the *evolution* of tacit knowledge. Strictly speaking, it is not true that our whole knowledge follows from tacit knowing. The tacit dimension is *more* than knowing. Polanyi's theory of tacit knowing was based on individual perception and Gestalt psychology. Comprehensive ontological categories, which are more than subjective (e.g. personal), could not follow from knowing *but only from* the evolutionary emergence of tacit knowledge. However, this process of the emergence of knowledge can only be interpreted as a kind of evolutionary epistemology and at the cultural level as a kind of social or collective epistemology. So, the tacit dimension of our knowledge is more than the individual component of knowing. It is the consequence of the comprehensive evolutionary emergence of tacit knowledge.

In my paper I will investigate the relationship between tacit knowing and tacit knowledge and establish the differences. Then, I will attempt to offer an interpretation of the evolution of tacit knowledge as the Janus faces of knowing and being. In section 1 I will investigate the structure of tacit knowing, then in section 2 the structure of skills. We will see that the two structures are the same, so, because skills are not knowing, this specific tacit structures follow from an independent common source and not from the epistemology of tacit knowing. In section 3 I will investigate the source, the ontology of the emergent structure of tacit knowledge, and finally in section 4 I will give an interpretation of knowing, to sketch the specific Polanyian relationship between knowing and being from an evolutionary point of view.

1. The Structure of Tacit Knowing

> Whenever we are focusing our attention on a particular object, we are relying for doing so on our awareness of many things to which we are not attending directly at the moment, but which are yet functioning as compelling clues for the way the object of our attention will appear to our senses. (Polanyi 1969c:113)

So, according to Polanyi, our cognition is directed by such "compelling *clues*" in the background, which although we are not attending to them (*subsidiary* awareness) still specify the object of our cognition (*focal* awareness). Clearly, the subsidiary and the focal awareness are not two levels but two different kinds of awareness. There is no focal awareness without subsidiary awareness, and in the same way, there is no subsidiary awareness without focal awareness. Though the subsidiary awareness determines the focal awareness still it is meaningless in itself, because it can manifest itself *only via* focal awareness. It follows that our cognition becomes necessarily *tacit,* since we are aware of the determining clues only in a subsidiary way.

To illustrate this with an example of Polanyi: the Danube, as a clue in the background, indicates to us that we sense ourselves moving on an *immobile* bridge; yet if we raise our head, thereby putting the Danube in the focus of our attention, then we do not sense *ourselves* moving but, instead, the Danube, which is, in turn, determined as a percept by the clues of the existence of riverbanks in the background (Polanyi 1969c:111).

From this example it follows that a thing that functions as a clue in another time and situation can be put *in the focus* of our attention, thus it can be explicable as well. This means that a subsidiary item is inexplicable (that is, tacit), because our knowing has such a kind of (focal-subsidiary) structure that every item becomes necessarily tacit in the subsidiary position and *not* because an actually subsidiary item is tacit *in itself.* An actually subsidiary item in another cognition as a *focal* item *can be* wholly explicable as well.

In the same way, it does not follow from the tacit structure of knowing that the focal items are necessarily wholly explicable. It is only a *possibility.*

So, although it is true that many times Polanyi introduces the concept of tacitness via his theory of tacit knowing, and that this is also his fundamental example for the working of tacit knowledge, still, the subsidiary items are tacit only because they cannot be explicable for the given observer and not because they necessarily cannot be explicable for someone else or in another situation. It follows that, from the tacit structure of knowing one cannot conclude the nature of our knowledge concerning the subsidiary items, that is, if our knowledge of the subsidiary items is tacit in itself or not. One can only conclude that these items function as tacit clues *in this* knowing process, and because in every human knowing act are such kinds of subsidiary items necessarily every human knowing act is tacit. Thus from the tacit triad (Polanyi 1968:30) the *integration* of subsidiary items to focal object plays the key role. Our knowing is tacit because its *integration process* is tacit; there are always determining subsidiary clues; but from this specific structure it does *not* follow what nature the focal and subsidiary items in themselves have.

So, in Polanyi's view, the structure of our knowing can be depicted in the following way: subsidiary items → tacit integration → focal object.

The concept of tacit does not equals the concept of subsidiary. The tacit means *more*. According to this idea, one has necessarily tacit knowledge concerning the subsidiary items only in the *actual* knowing act but the integration process is *always* tacit *in every* knowing act. Strictly speaking, while a subsidiary item can be explicable in another knowing act as a focal object, our tacit integration process of knowing can never be replaced with something else. That is possible only in the case of the ideal knowledge possessed by Laplace's demon, because his knowing process is wholly explicable, that is, *deductive*, free from the necessarily tacit integration process of our knowing.

> This difference between a deduction and integration lies in the fact that deduction connects two focal items, the premises and consequents, while integration makes subsidiaries bear on focus. (Polanyi 1968:32)

Laplace's demon simply does *not* have the same tacit structure of knowing as we do. His structure of knowing is the following: focal object → explicit deduction → focal object.

The core of the Polanyian criticism is that this ideal structure of knowing is not true and cannot be true for the structure of human knowing as it was supposed by modern Western philosophy. The modern critical Western philosophy shook logically determined foundations for knowing, however, from an evolutionary point of view the biological and cultural determinants cannot be eliminated for an ideal, wholly explicit structure of knowing because they are the foundations of knowing (section 4). So, when, for example, a neurologist depicts our tacit knowing by explicit mechanical steps in a Laplacian way she makes a "deceptive substitution" (Polanyi 1962:141) and necessarily speaks about something else, the physical conditions of our knowing and not about our real knowing act (Polanyi 1968:39).

So, one cannot conclude the tacit nature of our knowledge from the tacit structure of our knowing. This is not the reason why Polanyi states that our knowledge is also as tacit as our knowing. Logically it is possible to conceive such a kind of demon who although possesses *only explicit knowledge items*, still his knowing process is not deductive as that of Laplace's demon but he integrates his knowledge items in exactly the same tacit way as humans do. This can be depicted in the following way: focal object → tacit integration → focal object. From the tacit structure of knowing tacit knowledge does *not* follow.

2. The Structure of Skill-Type Knowledge

> If I know how to ride a bicycle or how to swim, this does not mean that I can tell how I manage to keep my balance on a bicycle or keep afloat when swimming. I may not have the slightest idea of how I do this or even an entirely wrong or grossly imperfect idea of it, and yet go on cycling or swimming merrily. Nor can it be said that I know how to bicycle or swim and yet do *not* know how to coordinate the complex pattern of muscular acts by which I do my cycling or swimming. I both know how to carry out these performances as a whole and also know how to carry out the elementary acts which constitute them, though I cannot tell what these acts are. This is due to the fact that I am only subsidiarily aware of these things, and our subsidiary awareness of a thing may not suffice to make it identifiable. (Polanyi 1969d:141-2)

I think Polanyi's example is quite clear. When someone rides a bicycle or swims she is aware of the components of action of which the bicycle riding or the swimming

consists only *subsidiarily*. From these subsidiary parts by an *integration process* the *focal whole*, that is, the bicycle riding or the swimming itself come into being. The integration process cannot be wholly explicated. It is *tacit*. So, in Polanyi's view, the structure of skill-type knowledge can be depicted in the following way: subsidiary items → tacit integration → focal object. It is the same structure as in the case of tacit knowing.

Naturally, one can try to make the process of bicycle riding or swimming explicit, e.g. using the Newtonian equations, but that will end in total failure, hence: "Such knowledge is ineffectual, unless known tacitly." (Polanyi 1969d:144) Contrary to tacit knowing, in the case of skills-type knowledge the subsidiary parts of the integration process are tacit not only because they are in the subsidiary position of the integration process, since if one put them into the focus of attention they would still remain partly tacit—as the case is in the balancing process. These subsidiary parts are such kind of *knowledge items*, namely how one pushes down on the pedals, holds the handle-bars, keeps the balance, etc., which as personal facts are tacit *in themselves*. So, in the case of skill-type knowledge besides the tacit integration process there are necessarily such kinds of tacit knowledge items, which are also tacit in nature. It follows that in this case conceiving a kind of demon who has explicit acting power is *not* possible. Explicit biking is beyond reason (Héder, Paksi 2012).

So, the structures of the skill-type knowledge and tacit knowing (subsidiary items → tacit integration → focal object) are exactly the *same*. Moreover, Polanyi asserts that face recognizing (Polanyi 1969d:142), scientific intuition (Polanyi 1969c:118), physiognomy (Polanyi 1969a:123), simple perception and tool using (Polanyi 1969a:127), as well as the understanding of words or a text have all the same structure (Polanyi 1975:70-5). One can understand the meaning of a sentence only if a person focuses her attention at the focal whole and if she is aware of the words from which the focal whole emerges by tacit integration only subsidiarily. Once an expert lector's attention is focused on the parts, e.g. on the letters, the words, and the spelling mistakes, then she loses the meaning of the whole text. The close connection among the different activities and the processes of knowing were also emphasized by Polanyi himself.

> The structural kinship of the arts of knowing and doing is indeed such that they are rarely exercised in isolation; we usually meet a blend of the two. (Polanyi 1969a:126)

For now, let us not ask why knowing and skill-type knowledge are so closely connected (section 3), but let us concentrate on the fact that significantly *different* activities have the very *same* tacit structure. It is clear that bicycle riding or swimming is *not* knowing. It follows that if they had the same structure as knowing, this tacit structure would not stem from the structure of knowing. Rather (and this is my point) these two different activities have the same structure because there is an *independent, common cause that determines both*.

So, the question is: which is necessarily common both in the cases of knowing and skill-type knowledge? The focal and subsidiary items, as we have seen, can be different (tacit or focal) but the integration cannot. This necessarily tacit integration determines the same structures of knowing and skill-type knowledge. It follows, and this is important, that the structure of skill-type knowledge is not rooted in epistemology of tacit knowing. Neither is the tacit structure of knowing. Now, the question is what the origin of the structure of tacit integration is which determines all of the structures of these different activities.

3. The Structure of Tacit Knowledge: The Origin of Tacit Integration

Searching for the origin of tacit integration it may be worth calling again Laplace's demon because, in several Polanyian examples, he plays the ideal "knower" of modern philosophy. As we have seen in the previous sections, the structure of tacit integration determines both our knowing and skill-type knowledge; however, it does not bear on the knowing of the Laplacean demon. The question is: why?

First of all, the Laplacean demon is *not* a person but a *bodiless intelligence* who knows all the fundamental physical laws. His perception has no limits and he can explicitly describe the entire fundamental physical universe at a given moment. From these explicitly detailed data he can conclude the actual state of the entire fundamental physical universe of any moment. From the point of view of modern philosophy concerning ideal knowledge the demon knows everything and his knowledge is wholly explicit.

Polanyi, however, denies that Laplace's demon knows everything (Polanyi 1959:48-9). For example, in contrast to us, Laplace's demon does not possess skill-type knowledge. This is the reason why his perception has no limits and is instantaneous. Contrary to this, our simple perception is based on such kinds of limited, subsidiary skills as e.g. the eye-moving (Polanyi 1997a:252). Moreover, according to Polanyi, the scientific intuition that fundamentally determines the scientific knowing is also a kind of limited, subsidiary skill (Polanyi 1969c:118).

So, human knowing, contrary to that of the non-personal Laplace's demon, is *based on skill-type knowledge*. The skill-type knowledge is necessarily tacit in nature. The subsidiary knowledge items from which the tacit integration creates the skill-type activities such as bicycle riding, swimming, simple perception, etc. cannot be wholly explicable.

As we have seen in section 1, logically it is possible to conceive a kind of demon who although possesses *only explicit knowledge* still his knowing process is not as deductive as that of Laplace's demon but it integrates its knowledge items exactly in the same tacit way as we do (focal object → tacit integration → focal object). Only from the tacit structure of knowing, tacit knowledge does not follow. Of course, the reason why our knowing is tacit, contrary to that of Laplace's demon, is not this

logical possibility but the fact that our knowing is based on skills, that is, on such subsidiary knowledge items, which are necessarily tacit in themselves by their very nature. It follows on the one hand, that tacit integration is not tacit by itself (e.g. in the case of my demon) but because of the necessarily tacit subsidiary knowledge items on which it relies, and on the other hand, that it is definitely the structure of our *skill-type knowledge* (subsidiary items → tacit integration → focal object) that determines the structure of our knowing and not vice versa.

Now, the questions are why these subsidiary knowledge items cannot be wholly explicable, and, why our skill-type knowledge, which determines our knowing is tacit. The Polanyian answer is that these subsidiary knowledge items are not and cannot be parts of our whole explicit knowledge, thus, they cannot be wholly explicable: they are tacit *in nature*. (Remember, the neurologist explicit Laplacian knowledge of our knowledge is not the same!) However, only wholly explicit knowledge about the world can be possessed by Laplace's demon. It follows that Laplace's demon is *not aware of* any of the subsidiary knowledge items in any way and *cannot be aware of* them or otherwise his knowing could *not* be wholly explicable and he could *not* possess the whole possible explicit knowledge about the world.

Polanyi describes this in the following way:

> Assume, for the sake of argument, that we posses a complete atomic theory of inanimate matter. We can then envisage the operations of a Universal Mind in the sense of Laplace. The initial positions and velocities of all the atoms of the world being given for one moment of time, and all the forces acting between the atoms being known, the Laplacean Mind could compute all future configurations of all atoms throughout the world, and from this result we could read off the exact physical and chemical typography of the world at any future point of time. But we now know that there is a great and varied class of objects which cannot be identified, and still less understood, by establishing their complete physical and chemical topography, for they are constructed with a view to a purpose which physics and chemistry cannot define. So it follows that the Laplacean Mind would be subject to the same limitation: it could not identify any machine nor tell us how it works. Indeed, the Laplacean Mind could identify no object or process, the meaning of which consists in serving purpose. It would ignore therefore the existence not only of machines but also of any kind of tools, foodstuffs, houses, roads and any written records or spoken messages. (Polanyi 1959:48-9) …a complete 'Democritean' or Laplacian knowledge can tell us nothing without relying on our personal [and tacit] knowledge of these comprehensive features. (Polanyi 1962:358)

Polanyi definitely denies the modern positivist notion that human knowledge can be made wholly explicable and asserts that, according to the different nature of reality, two different kinds of human knowledge exist in the *ontological* sense: *tacit* and *explicit*. The Laplacean demon *cannot* recognize any comprehensive entity in the world because it possesses *merely* explicit initial knowledge, thus his further

knowing is also limited to the wholly explicit universe of fundamental physics. His knowing starts from the knowledge of the laws and actual state of the fundamental physical entities (this is his initial knowledge). The reason why this is wholly explicable is that the object of his knowing activity is also the always explicable fundamental physical substance. His knowing process can be depicted in the following way: explicit initial knowledge of explicable physical substance → explicit deduction → new explicit knowledge of explicable physical substance.

Contrary to this, our knowledge is based on such kinds of tacit knowledge items (this is our initial knowledge) and by their tacit integration, we can *also* recognize complex, comprehensive, *emergent* entities, which cannot be wholly explicable. This can be depicted in the following way: tacit previous knowledge → tacit integration → tacit, personal knowledge of emergent reality.

In the above quotation Polanyi mentions machines and tools as examples for these kinds of comprehensive, emergent entities. Nevertheless, living organisms as "machine type" entities are *also* comprehensive, emergent entities (Polanyi 1969b; 1997b). Naturally, the same is also true for the human body and its organs too, that determine our knowing. Thus our knowing, as I argued above, has to be necessarily tacit according to these skill-type, tacit knowledge items such as eye-movement, body control, etc. Our initial tacit knowledge, however, consists not only of these skills-type knowledge items, according to which we recognize a frog as a frog, but e.g. of the knowledge of the emergent characteristics of the frog, that it is green, it croaks, etc. So, after all, this initial tacit knowledge is the very source of the tacit structure of our knowing, that is, it is rooted in the tacit foundations of the hierarchy of our knowledge, and not in the simple fact that it is determined by subsidiary clues.

One can establish now that our tacit knowledge is *primary* to our tacit knowing and that it has *ontological* characteristics. However, this does not mean that our tacit knowledge possesses some kind of explicit, objective reality as it is in the case of the substantial physical entities but possesses a kind of personal, emergent reality according to Polanyi's entirely new definition of reality.[1] For example:

> Real is that which is expected to reveal itself indeterminately in the future. [...] This conception of reality and of the tacit knowing of reality underlies all my writings." (Polanyi 1964:10) Or: "...man has the power to establish real patterns in nature, the reality of which is manifested by the fact that their future implications extend indefinitely beyond the experience which they were originally known to control. (Polanyi 1962:37)

So, our knowing possesses ontological characteristics (Polanyi 1969d:141; 1967:13) not by itself but by *the tacit foundation of our knowledge*. But, of course, our knowing relied on this tacit foundations can lead us up into the levels of explicit knowledge. This means that *there is no* explicit knowledge without tacit knowledge. Tacit

[1] I investigated Polanyi's theory of emergence and its reality in other papers (Paksi 2010b; 2011).

knowledge, however, *can exist* without explicit knowledge, and we can already find this in animals[2] (Polanyi 1962:71-7). The hierarchical structure of our knowledge fundamentally consists of these two different kinds of knowledge (tacit knowledge → explicit knowledge).

> While tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is *either tacit* or *rooted in tacit knowledge*. A *wholly* explicit knowledge is unthinkable. (Polanyi 1969d:144)

These hierarchical tacit foundations of our knowledge are the reason why we can surpass the level of the explicit knowledge of Laplace's demon and can recognize such kinds of comprehensive, multileveled emergent entities as machines, tools, and living beings. For Polanyi this is a great achievement of meaningful life (biology) and the Laplacean demon is only a deceptive logical illusion of modern Western philosophy, which tries to reduce our knowledge into the meaningless territory of matter (physics).

The fact that in Polanyi's view the hierarchical structure of our knowledge has two fundamental emergent levels (tacit end explicit) does not mean that inside the fundamental levels one could not identify further hierarchical sublevels. According to the structure of tacit integration, for example, bicycle riding consists of at least two different hierarchical sublevels; one of them is the sublevel of such different, independent muscle-coordinating further subsystems like the pushing of the pedals, holding of the handle-bars, keeping the balance, etc., and the other is the sublevel of the integrated tacit activity, that is, the sublevel of bicycle riding itself. So, skill-type knowledge is a typical case of multileveled, tacit knowledge, which consists of different integrated, lower level knowledge items. Polanyi's most detailed example for the tacit integration of multileveled knowledge items is speech. The hierarchical structure of speech consists of five emergent sublevels building onto each other. These levels are the following:

> …the production (1) of voice, (2) of words, (3) of sentences, (4) of style, and (5) of literary composition. Each of these levels is subject to its own laws, as prescribed (1) by phonetics, (2) by lexicography, (3) by grammar, (4) by stylistics, and (5) literary criticism. These levels form a hierarchy of comprehensive entities, for the principles of each level operate under the control of the next higher level. (Polanyi 1967:35-6)

There is another aspect in this example that can be interesting for us, since one can recognize the gradual surpassing of the tacit level of our hierarchy of knowledge. According to this, the first sublevel of speech, that is, the production of voice, is a

[2] Or more exactly, in all living beings, because "*knowing belongs to the class of achievements that are comprised by all forms of living*" (Polanyi 1962:403).

barely explicable, skill-type tacit knowledge like bicycle riding while the last, the production of literary composition is a mostly explicable one. An explicit text, for example, an important law of the legal system is such kind of explicit sublevel of our hierarchy of knowledge which, on the one hand, significantly determines our everyday life (that is, our lower level, mostly tacit activities like, e.g., bicycle riding if the text in question is the Highway Code). However, on the other hand, the text's interpretation and application are always rooted in these lower level tacit sublevels. Nevertheless, this does not mean that an explicit text such as an important law of the legal system is not a real emergent entity at the higher explicit levels of our hierarchy of knowledge.[3]

4. Knowing and Being

We have seen that previous tacit knowledge makes the process of tacit knowing possible. This previous tacit knowledge determines, on the one hand, the fundamental structure of tacit knowing, which leads to the tacit integration of comprehensive emergent entities, and, on the other hand, the emergent hierarchy of our being. Since our emergent being is nothing else but the continuous activities of the levels of the hierarchy of our knowledge, as we ride a bicycle, swim, talk, follow the rules and laws, or get to know something, etc.

Nevertheless, tacit knowledge is primary to tacit knowing *only if* one speaks about unambiguously individual knowing, according to the commitments of modern Western philosophy. In this case a knowing activity of a scientist is determined by several tacit knowledge items.

(1) A significant part of these items is tacit because in the actual knowing process the scientist is aware of them only subsidiarily. Expressed in a Kuhnian way, this part of these items consists of the first two, mostly explicit elements of the disciplinary matrix, 'symbolic generalizations' and 'metaphysical paradigms', that is, of the scientific theories (Kuhn 1996:182-7).

[3] This might be worded in the following way. Explicit knowledge exists at higher cultural levels above the level of the pure individual minds in accordance with his own higher-level principles. To illustrate this, here is an example: due to this autonomous existence, using some newly excavated written memories of a long forgotten and vanished people, a historian can reconstruct the mostly lower level, significant parts of the culture, language, and life of the people who at one time led to the drafting of that once vanished and now excavated explicit written memories. This would not be possible if the higher level had been vanished forever and had lost its autonomous existence when the lower levels vanished, which provided the necessary preconditions of its drafting. Nevertheless the uncovering of the culture of the long forgotten and vanished people cannot be completed in this way because the culture and knowledge of a people is in part necessarily tacit. (At the same time, the excavation of the material memories could deepen the understanding of the culture of long forgotten people.)

(2) Another important part of these items exists at those cultural levels of the hierarchy of our knowledge where explicit and tacit knowledge items are interwoven as deeply as we have seen that in the case of speech. The working scientist may not be aware of this part of his knowledge at all. Expressed in a Kuhnian way, this other part of these items consists of the third (values) and forth (exemplars) elements of the disciplinary matrix (Kuhn 1996:182-7). Polanyi himself describes these knowledge items as *personal commitments* of the scientists to certain scientific values and methods that underlie and determine their scientific activity. These commitments and other knowledge items are manifested at the cultural level of the scientist's community in the different scientific institutions and scientific activities, that is, in the *conviviality* of the scientific community.

(3) Another significant part of these items is rooted in deep, biological levels and cannot be explicable, as we have seen in the example of bicycle riding in section 2 (Polanyi 1962: e.g. 69-132). This part has no equivalent in Kuhnian terms.

These different types of tacit knowledge items are primary to tacit knowing *only if* one speaks about merely *individual* knowing. Polanyi speaks about tacit knowing in this way when he uses it as an example for the functioning of tacit knowledge and he also speaks about tacit knowing in this way when he wants to show that individual knowing has a tacit structure in itself, contrary to positivist conception of knowledge. But when he wants to show how these tacit knowledge items are formed during our intellectual life and in the process of socialization when they pass from one generation to another he never speaks about this individual kind of knowing but about a *common, culturally sustained* process of knowing embedded in human *conviviality* (Polanyi 1962:203-11). In this sense he says, "knowledge is an activity which would be better described as a process of knowing" (Polanyi 1969a:132).

Here, knowing is not an idealized individual activity but first of all a *learning* process, which has another necessary precondition beyond the knowing person, that is, the accepted *authority*. According to this, the foundation of knowing in Polanyi's view is not a mechanical, rational scientific process but *trust,* which was formed by the conviviality of generations.

> The current cultivation of thought in society depends throughout on the same kind of personal confidence which secures the transmission of social lore from one generation to the next. (Polanyi 1962:208)

For Polanyi the acquisition of the most simple behaviors, of more complex skills, and of the higher level scientific knowledge also follows this pattern. According to one of his favorite examples from his personal life, a medical student learns the list of symptoms of different diseases from medical textbooks but only during her medical practice will she be able to acquire the knowledge of how to get well-established diagnoses, according to the observed symptoms (Polanyi 1969a:125). Here, there is not merely a tacit integration of an individual knowing but a working

of a complex, cultural hierarchy of knowledge. The medical student has to show trust in different, higher-level scientific (e.g. university) and cultural (e.g. clinic) institutions to be able to produce well-established diagnoses, that is, in order to perform the tacit integration of the symptoms, she submits her simple perception to a complex cultural knowledge-system.

So, our tacit knowledge is the achievement of a collective knowing process. Nevertheless, it is only *partly* true because we are a kind of intelligent animal that has certain tacit knowledge items rooted fundamentally in the *biological* levels (Polanyi 1962:69-77). This means on the one hand, that we also possess knowledge items that had emerged before our intellectual or social life started, and on the other hand, that our several knowledge items supersede the biological levels only by the influence of our higher level cultural knowledge. Thus, is our tacit knowledge the achievement of an *emergent evolutionary knowing process*? And afterwards is it the achievement of a collective knowing process? To the first question, the answer can be affirmative if we accept that the emergent evolutionary process during which the biologically rooted tacit knowledge continuously cumulates by the "continuous proliferation of germ plasm" (Polanyi 1962:386) is a kind of knowing process itself. We can accept even more easily that the answer to the second question is also positive, that is, our tacit knowledge is the achievement of a collective knowing process. However, in Polanyi's view these two processes are only the two fundamental stages of the same emergent evolutionary process, namely the stages of biological and of cultural evolution (Polanyi 1962:385-90; Paksi 2010a). This is the reason why I assert that, according to Polanyi, the human tacit knowledge is the achievement of an emergent evolutionary knowing process of the generations of our phylogenesis. The evolutionary epistemology of tacit knowing *precedes* the actual ontology of tacit knowledge. By this knowing process our human knowledge and human *being* emerges. At the same time, this also means that this evolutionary epistemology is *also* an ontology. So, I believe in accordance with Polanyi, that neither tacit knowledge precedes tacit knowing nor tacit knowing precedes tacit knowledge, but in fact, the two are *inseparably interwoven*.

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If the publication history is important:

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