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The act of knowing: Michael Polanyi meets contemporary natural science

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Abstract

In the aftermath of the modern science world scientists are still searching for some kind of ontological and epistemological common ground. In this paper I try to show that we, by the aid of Michael Polanyi`s concepts of knowledge, of personal as well as objective knowledge, and his descriptions of the tacit dimensions in the process of knowing, can take some substantial steps toward a better understanding of the contemporary scientific conduct.

Keywords: Ontology; epistemology; knowledge development

Introduction

The contemporary natural science view

In the aftermath of the modern science world scientists are still searching for some kind of common ground. In a paper from 2005, Grobstein gives a description of a contemporary method for pursuing natural science, which he contrasts to, and represents as a critical perspective upon, the modern science's linear scientific method. The paper provides many constructive thoughts, adding more to the box, that among other things aim to bring down the borders between science and the more general human culture. The paper also embraces a diversity in scientific conduct, and it is requested a more open-minded attitude towards different scientific perspectives. Furthermore, it also emphasizes that it is important to accept that science has a personal, call it human, element.

One may briefly summarize this more contemporary scientific method in the following manner: The classical hypothesis is replaced with a summary of observations, which then again provides predictions about future observations. The experiment is changed to making new observations to see if they match the predictions. If they do not, the predictions are falsified. However, if the observations match the predictions, it is only to be regarded as a truth in the sense that it is a summation of all observations made up to the present. Thus, a truth can never be finally verified, and must be considered as only provisional. The scientific process is hence a process of continual revision, in which scientific statements cannot be considered as more than tentative truths that reflect the human perspectives from which they arose and that become progressively less wrong (Ibid).

In my opinion this contemporary version of scientific conduct, however, does not take us very far beyond the modern science and knowledge view. I believe we are still located within the modern science and knowledge view, at least within some post-positivistic thoughts, perhaps now in the direction of the theory of critical realism. Within this view, reality is believed to exist independent of science's knowledge of it (Miller and Tsang, 2010), and although it upholds the possibility of achieving truthful knowledge, it also highlights that it is my human limitations that impair my ability to reach any objective and universal knowledge (Ibid). There is nothing in the methods of science that guarantees success in arriving at an absolute truth.

Consequently, every scientific knowledge claim and every scientific theory should be critically evaluated and tested through thorough empirical observations (Ibid).

At first glance, these thoughts may seem like indicating progress in how we envision contemporary natural science. Even though I acknowledge that it perhaps suggests something in the right direction, I believe we are still far from taking any vital steps. Although it is critical to modern science's craving for absolute certainty, and this critique is based on the thought that each observation or each perspective has both a personal and contextual element, these elements are only conceived of negatively. It inadvertently leans toward a kind of subjectivism, implying that this is something I as a scientist ought to free myself from in order to be in a position to come to objective and neutral knowledge of any subject matter. Another problem is its emphasis on the empirically observable hard facts of the world. This suggests a reductionism delimiting the scope of science and narrowing down what can be considered as real. Such reductionism perpetuates the belief that some knowledge claims that have arisen from the hard sciences are more truthful, and have more epistemological value, than knowledge claims that have arisen from the humanities.

In accepting this kind of realism, we also seem to have to accept the idea that on the other end of the implied epistemological scale, in the opposite direction from this realism, it exists something resembling pure relativism. Furthermore, this provisional empiricism suggests that the next observable fact is able to falsify whatever theory or conceptions the scientist held in the first place (Popper, 2002). This amounts to a skepticism of theory and of human thought and rationality in favor of the next observable fact detected, and, hence, is problematic. Additionally, although this view seems to accept rationality, it is in my opinion rationality only in a reduced form, as pure logic.

The objective reality that this scientific view believes to exist *out there* is perhaps then not a goal to attempt to attain because it would imply giving up my own human heritage, as well as implying that these truths are cut off from the context of which they are part. The desire to reach a neutral and objective understanding stripped of any particularities of human perspectives and contextual references would be the view from nowhere, and thus completely barren of human meaning. Heidegger contradicts this reducible objectivity by

claiming that every concept has to be seen in light of a system of reference, and even that it is this contextual relation that makes the concept what it is (Ihde, 1993). Furthermore, the aim of the scientific endeavor cannot be knowledge just for the sake of knowledge. It has to lead to some kind of human understanding, and everything we understand we interpret in view of something we already have understood. Hence, if I want to understand something, I have to bring myself, my pre-understanding, into play (Gadamer, 2003). Consequently, this is what constitutes the very starting point of any new understanding. The completely objective scientific truth, cut free from its context and the individual subject who holds it, thus becomes something that exists only in a scientific vacuum, something comprised of no human value or meaning, thus becoming, well, meaningless.

Therefore, I do not think we have come much farther than the modern knowledge and science view enabled us to come. I do not believe we have reached any more clarity regarding how new knowledge is developed. However, in my opinion Polanyi can be a guide out of this deprivation. In this paper, I will thus, by examining his concepts of knowledge, of personal as well as objective knowledge, and his descriptions of the tacit dimensions in the process of knowing, try to show that we can take some substantial steps toward a better understanding of scientific conduct. I will try to show that it is possible to acknowledge an expanded way of considering objectivity where it is also possible to recognize the personal and contextual elements of scientists - not as something unfortunate - but as the ultimate starting point of any scientific endeavor, as well as a presupposition for the discovery and establishment of any new knowledge.

Polanyi and the Act of Knowing

The basis of his work

A question then arises: Where did we go wrong? Where did we begin to believe that our humanity would deprive us of the possibility for scientific truthful recognition? Where did we lose the human in the process of knowledge development? Where did we begin to distrust the human faculty of thinking, of upholding ideas and theories, which, according to the contemporary philosophy of science, natural sciences are willing to abandon whenever a new observable fact tells us to? According to Polanyi, we have to go back to the scientific revolution to understand how this view of science originated. As emphasized in the modern natural

science and knowledge view, the scientific revolution was a turning point in the history of science. It has had a tremendous positive effect upon modern science as well as modern society in general. It created an understanding of humans, of science and of knowledge, which has been the preferred one up to the present day. However, we can wonder if we by our somewhat naïve confidence in these thoughts perhaps at one point have let it go too far, and that this has contributed to some of the problems we still face within natural science, and from which we apparently have some difficulty freeing ourselves.

The primary problem with the scientific revolution, according to Polanyi, was Copernicus' discovery of the earth not being the center of the universe. In a symbolic, and I will believe not intended manner, this, in itself an exceptional scientific achievement, resulted in removing human beings from the central position in the universe. This manifested in some kind of idea that the perspective I as a scientist, or even as a human, ought to consider the world from, should be an objective and neutral point of view. Polanyi's counterargument was however that it is impossible for humans to step outside themselves to view the universe, and that any efforts to reject this obvious truth, are almost absurd (Polanyi, 1958a). Secondly, as a consequence of the revolution, there emerged a conception that the ultimate reality was composed of material substances such as atomic particles, and that it was possible to come to some kind of absolute, certain and universal knowledge about those substances. This reductionism went so far as to suggest that even human beings were nothing more than a somewhat random collection of atoms, devoid of any purpose or meaning (Polanyi, 1965b). This led to a desire within modern science to explain everything within the frame of natural, or mechanical, laws. According to Lissack and Graber (2014, in Lissack, 2015) and Lissack (2015), all that mattered within this view was to give observer, context and belief independent descriptions and representations of indexical properties. As the idea of this perfect, universal, knowledge arose, any ambiguity, something science previously attempted to illuminate and clarify, now became something science aimed to demolish (Ibid). Further, this view also created a disbelief in the very existence of immaterial things, things that could not be observed empirically, or discovered by pure logic. Furthermore, alongside these problems, Cartesian doubt also arose and nourished this skepticism toward our self and our humanity (Bergo and Hide, 2005, Merleau-Ponty, 2008).

Nevertheless, within this mechanistic belief system, the modern natural scientist and his search for universal knowledge has become an ideal. Observation and registration of the hard facts of reality, within a dualistic or distanced framework, have become the essence of scientific practice. Furthermore, the worship of observable facts has made the scientist willing to uphold theories only temporarily. Whenever a new observation contradicts a theory, idea or thought I may have held up to that point, I must be prepared to drop it immediately in favor of the new observation (Polanyi, 1958a). Furthermore, and even more peculiar, if a theory cannot be tested by observation as it is, I should attempt to revise it with the aim of making its predictions compatible with measurable quantities. Polanyi also highlighted that although the modern scientist is excellent at performing according to whatever methods he applies in his endeavor to observe the facts of today, he would be perplexed in his search for something worthy of knowing (Polanyi, 1965b).

After all, the things that are most interesting to gain knowledge about are things “that are seen, felt, heard and smelt” (Ibid, p. 13), things that in one way or another affect us as humans and provide something meaningful to humanity, which is something the modern mechanical science view fails to accomplish on its own. This is because gaining such knowledge requires the action of sentient human beings, human beings capable of perceiving, appraising and understanding the magnitude of information that our senses continually receive. The first thought following this might be that this has nothing to do with science. This, however, is a misconception, because Polanyi did not want us to abandon all striving for scientific knowledge worthy of being acknowledged as objective and to some extent even universal knowledge. Rather he wanted to show that it is possible to come to such knowledge of even immaterial levels of reality and thereby re-establish a scientific acceptance of higher forms of existence (Ibid).

Stratified ontology

The first example Polanyi used to emphasize his thinking was the clock. He pointed out that the mechanical science view on its own is as unable to tell time, just as the chemical testing of a printed page of text is unable to give information about its content (Ibid). By this, Polanyi showed that every machine, like the clock, and even any machine-like system, like living beings, consists of at least two levels. The lower level consists of isolated parts controlled by

whatever laws or principles apply at that specific level, while the upper level embodies the functional principle of the system as a whole, making visible the united meaning of the parts (Ibid). This is not, however, to say that material things, on its own, are of no special importance. Even the smallest substances of nature are of great significance, but the meaning lies essentially in higher levels, where the isolated parts reach a united and functional meaning. An example could be some sort of physiological data, e.g. human blood measures related to exercise. On its own, any blood value can tell us almost nothing. It is first when it is contextualized, when it is considered in relation to its holistic functionality that its practical applicability becomes visible and it acquires meaning.

Furthermore, as we perhaps begin to understand, this stratified ontology does not have to consist of only two levels. Again, as shown previously with the physiological data on soccer players, there can be several levels, and even series of levels, that together form a hierarchy of rising levels of existence (Polanyi, 1961): like a *hierarchical topic map* indicating how topics of a subordinate level join in the construction of higher order topics in a logic manner (Scott, 2004). When living human beings are put under examination the complexity of this hierarchy becomes especially visible. Furthermore, as the meaning is found in the comprehensive entities which the parts jointly form, this also implies that the meaning becomes increasingly rich at each successive level and that it reaches its most complete form at the very top. Hence, it is clear that the goal of science according to most contemporary views of natural science, upholding a belief in an objectivity corresponding to a reality in its most reducible form, is a mistaken target. As Polanyi (1965b, p. 15) emphasized:

What is most tangible has the least meaning and it is perverse then to identify the tangible with the real. For to regard a meaningless substratum as the ultimate reality of all things must lead to the conclusion that all things are meaningless. And we can avoid this conclusion only if we acknowledge instead that deepest reality is possessed by higher things that are least tangible.

The power of integration

When I try to come to knowledge about any comprehensive entity at an upper level, it thus becomes clear that I have to rely on the elements of the lower levels as clues. Inspired by

Gestalt psychology, and hence using sensory perception as an analogy to the act of coming to knowledge about any comprehensive entity, Polanyi furthermore emphasized that to be able to see reality as it is, I have to attempt to integrate information from the whole area of my vision (Polanyi, 1961). Consequently, as I move upwards in the ascending hierarchy of this stratified ontology, the number of clues I have to include, as well as the complexity between them, increases. Some, perhaps even most, of the clues on which I rely come from within my own body. When I observe an object like a pen, I do so by performing intelligent operations wherein sensory inputs are integrated together with internal reactions (Polanyi, 1965b). However, when my perspective during observation changes, whether due to an adjustment of angle or lighting or perhaps a rotation of the pen, the clues on which I rely, may also change. Still, the pen remains to me an unchanged object (Ibid). If I, on the contrary, was to manipulate my vision, the scenario would alter. Polanyi describes how, if I were to look at the same pen through a pinhole in a sheet of paper, some of the periphery clues on which I rely to form the image are lost, which causes some of the pen's solidity as an object to become lost to me as well (Ibid).

Furthermore, to be able to identify the whole at all requires that I reduce my awareness of the clues constituting the whole. If I focus my attention on any given clue, and not on the whole, to which it is contributing, my ability to grasp the joint meaning becomes reduced. When what is the holistic object at one level becomes a clue at a higher level, this can be challenging. Nevertheless, as seen, some of the clues exist only in my peripheral vision; some are not known to me, and some are perhaps not possible to specify. In a sense, I am only aware of them as they make it possible for me to come to knowledge of an object. By this, I understand that I do not attend to these clues, but that I rely on my "subsidiary awareness of them for attending to the coherent entity to which they contribute" (Polanyi, 1965b, p. 17). This can be understood as a tacit reliance on my awareness of particulars, which are fused and formed into a meaningful way of perceiving them. Polanyi's primary example of this is the ability to recognize a physiognomy, such as a human face, by the integration of its particulars, while being unable to specify the particulars themselves (Polanyi, 1966). Often we just "see" something, something that just appears right in front of us, something in which its emergence just seems perfectly rational. Perhaps it's something making sense and which I know is as it ought to be, or perhaps the opposite, something that does not make sense and which does

not seem to be as it should. However, such incidents occur most often without us being able explicitly to describe what we see. It feels like a hunch or like a form of intuition. As I now understand it though, it is something else – something more.

Knowing and understanding

This tacit integration is an interpretive exertion. As seen, it is as if I understand something, but am unable, at least to some extent, to explain how I do so. It is exactly in the exercise of comprehension that the organization of tacit knowledge best becomes visible. What is interesting, then, is that this faculty of comprehension is one of the very things that the mechanical science view has refused to acknowledge. It has denied the possibility of the existence of comprehensive entities distinct from their particulars. For Polanyi, however, things that are not understood can neither be claimed to be known: Comprehension is never absent in the process of knowing and is in fact, to him, “the ultimate sanction of any act of knowing” (Polanyi, 1961, p. 4). Based on this, another clarification also emerges, which, although not presenting anything really new, is for me an important reminder. That knowledge is linked to understanding emphasizes so clearly that knowledge is not something static. Polanyi hence claimed that it would be better described as a process of knowing.

To exemplify this process, Polanyi (1958a) at one point describes it in relation to the way a medical student gradually learns how to diagnose pulmonary diseases based on X-rays. Initially, the student is only capable of seeing the basic anatomic structures of the radiogram, which naturally enough can be spotted as shadows on a light background. Gradually, however, he will be able to leave these most prominent elements and begin to see the lungs more holistically. Eventually an understanding will arise where the student becomes able to rely on an increasingly vast number of clues, together making up the joint meaning of the radiogram. Then, “a rich panorama of significant details will be revealed to him: of physiological variations and pathological changes, of scars, of chronic infections and signs of acute disease. He has entered a new world” (p. 106).

In-dwelling

Within this conception of knowing, it has become clear that I know things by relying on my awareness of them in order to attend to something else. My reliance upon these clues is then

again something I gradually learn to do. To a great extent, my knowledge of these clues is virtually entirely based upon the fact that I rely on them when I attend to another thing. I have also mentioned that some of these clues are within my own body. In a sense, my body is a collection of clues that I rely on when attending to something else. Furthermore, I rarely identify my body as an external object. However, I have gradually learned to rely on it when I observe, or operate within, the external world. Thus, the way I have come to know my body is exactly through the attendance to something else. The knowledge that I have, and continue to develop, about my body, is acquired by living in it. This leads us to Polanyi's (1965b) concept, of this subsidiary knowledge, as a knowledge I have of my body by dwelling in it.

Every new clue that I come to rely on in any circumstance is exactly an enrichment of this bodily reliance, which he describes as an "extension of our bodily existence to include things outside it" (Polanyi, 1961, p. 6), and illustrates with the example of a hand-held tool. In use, the tool becomes an extension of the person's hand, but the person cannot express how he uses the tool any more than he can express how he uses his hand (Polanyi, 1966). Hence, when we come to knowledge or understanding about something new, or become capable of performing a new skill, we become able to integrate, or internalize, more clues by this very act. It is an expansion of our horizon of understanding. Every step of comprehension involves an expansion of our self into a new dwelling place (Polanyi, 1961).

The structure of this form of tacit knowing can be described as a triad consisting of the subsidiary particulars, the focal target and the knower, who links the first to the second (Zhenhua, 2006). The way we understand any external objects is through some efforts inside our body, and from these internalized processes, we attend to the qualities of these external objects. This may be understood as a conversion of our bodily experiences into the understanding of things outside, and these processes are to some extent present in all processes of knowing (Polanyi, 1966). These bodily experiences, moreover, can be understood in the direction of the hermeneutical pre-understanding, which forms the horizon of understanding from which we view the world. Based on inherent, embodied and internalized knowledge, our body becomes the ultimate faculty for all external knowledge (Ibid). Hence, we always attend to the world, more or less intelligently, from our body (Ibid).

This way of thinking is present at all levels of Polanyi's stratified ontology. In the same way that I have gradually learned to integrate information from a variety of sources into my decision-making in the laboratory, I can also attend to other human beings' minds. By the act of empathizing, it is possible for me to come to knowledge about another person's mind by in-dwelling in its expressions (Polanyi, 1961). For this, however, I have to create a special, intimate relation with the person to whom I am attending. I have to create what Polanyi describes as a life-sharing partnership based on equality with the person (Polanyi, 1965b). Furthermore, in this way of thinking, the categorical differences between the way we know tangible and intangible things become almost invisible. They are left, not as fundamentally different kinds of knowledge, but rather different variations of the same kind of knowledge. There may be different compositions, amounts and levels of the ingredients that make up the sum, but the sum, whatever it is, is the same kind of sum.

Within this hierarchy, the amount of information, the number of clues and the overall complexity increases with each level. In a sense the background or the context for the object, to which I attend, becomes less static and more difficult to control for. Hence, my abilities, cognitively to process information, to see patterns and connections, as well as my intelligent powers to interpret, judge and comprehend, become especially important, the higher up in this hierarchy I move. Furthermore, such, call it, ethical knowledge view, seem vital to at all be able to establish the required life-sharing partnership with the person I am attending to, because if I am to understand another human being, I have to acknowledge him for what he is. I have to approach him open-mindedly, to try to assume his perspective, to build a bridge from me to him. In a sense, our horizons of understanding have to melt together (Gadamer, 2003).

The modern natural scientific view of objectivity, wherein the ultimate reality corresponds to reductionism, is then only to be understood as more complete or finished, compared to the more idiosyncratic sciences, in that there are fewer clues and less complexity involved in the act of comprehension. The act of comprehension is, however, the same. The attempt to understand a physical phenomenon of the world requires the same kind of empathic immersion in the object to which I attend (Wackerhausen, 1997), as the attempt to understand another human being. It is just that the higher the level, the deeper this immersion

in the subject matter must be (Polanyi, 1958a). Further, this immersion needs not only to be deep. It also needs to be wide. As the complexity and the amount of potential subsidiary systems increases, comprehension requires some sort of inter- or transdisciplinary approach where one attempts to “build bridges between different knowledge domains” (Scott, 2004, p. 1367). However, the problem is that the modern science view has reduced our understanding of the process of knowing to methodological rigidity and pure logic. In my opinion, there is more to the natural scientific practice than this implies.

Two kinds of knowledge

Personal and objective

To sum up then, the process of knowing is basically the same, independently of what is to be known, and although variations exist, different kinds of knowledge have the same basic constituents. The two main ingredients that form knowledge as a whole are, as described, the subsidiary clues and the united entity that the clues together constitute. The clues are, according to Polanyi, the personal element of knowledge, while the joint entity is the objective element of knowledge (Polanyi, 1961). Hence, it becomes clear that Polanyi believed human knowledge to be of two varieties: an objective one resembling the modern view, which may be described as explicitly expressible knowledge, and a personal, not completely linguistically expressible, embodied and action-oriented knowledge, consistent with a person’s ability in knowing and action (Polanyi, 1958b). Thus personal knowledge is, as also previously described, primarily tacit knowledge. As we have seen that these tacit processes contribute to every act of knowing, the personal element is also present in all processes of knowing.

There are two dimensions of tacit knowledge, above also briefly mentioned. The first dimension, referred to as tacit knowledge in the strong sense, consists of skills or crafts, and is often referred to as *know-how* (Ryle, 2000). It is something which is not possible to express verbally, and hence discloses a gap between our ability to execute any action and our ability to express verbally what we do (Zhenhua, 2003-2004). The second dimension, tacit knowledge in the weaker sense, is a more cognitive one, called *connoisseurship*, which consists of deeply integrated beliefs, assumptions, ideals and mental representations that often are taken for granted and which shape the way we perceive the world (Nonaka and Konno, 1998). Within

this dimension, we find knowledge that is not verbally inexpressible, but rather something, it is, perhaps, necessary to keep within our subsidiary awareness in order to maintain our focus on the target to which we aim to attend. Further, it can also be something we understand, but that we are not capable of giving complete and precise expression to. However, this does not imply that it is not verbally expressible in principle (Zhenhua, 2003-2004).

Nevertheless, tacit knowledge is the basis of all explicit knowledge. All explicit knowledge has a tacit root and, as described, tacit powers are the ultimate faculty through which humans acquire and hold all knowledge (Polanyi, 1966). Even for the most objective and explicit knowledge, we have to rely on tacitly comprehending it to get hold of the meaning of any statement, and this process is a process based on tacit powers of the knower (Zhenhua, 2003-2004). Whatever explicit data coming out of my scientific conduct, has no meaning before I have placed it in its context, where I view it in light of some background. In this regard, I might highlight that even Einstein emphasized that the physical concepts science deals with are creations of the mind, and not something fully determined by the external world (Einstein & Infeld, 1938, in Grobstein, 2005). The way any explicit statement has to be tacitly comprehended was also something Wittgenstein highlighted. He stated that the meaning of any concept was found in the way it was used (1969/2005). In the introduction to the Norwegian translation of his book *On Certainty*, Bergo and Hide (2005) offer the example of the poor student who informs his parents that he has bought a car and the parents reply, "Car!?" They then turn the scenario around: This time the parents inform the poor student that they have bought him a car and he replies, "Car!?" The sentences expressed are the same, even the linguistic signs are the same, yet the meanings of the two statements are significantly different, and can only be understood, if the context is equally understood. Polanyi therefore argued that it is impossible to acknowledge the existence of a completely explicit knowledge (Zhenhua, 2003-2004), claiming that despite the fact that language expands human intelligence well beyond the domain of tacit knowledge, the way we use language remains tacit (Ibid). Even when I push my horizon of explicit knowledge forward, this will require a renewal of the linguistic framework that I hold; this very act is only possible if I can go beyond the exact framework that I possess at this very moment (Ibid).

Completely explicit knowledge, the previously described modern ideal of perfect knowledge, therefore does not exist. Explicit knowledge is better understood as the tip of the iceberg surfacing the water, which strongly depends on the tacit fundament below the surface. What is visible is just a fraction of the whole. Any knowledge expressed is thus never equivalent with the knowledge of the person expressing it. I believe that we should consider any verbal or written explicit and objective knowledge statement as an expression of our knowledge and not as the knowledge itself, in the same sense as any expression of our skills is just an expression of these skills and not the skills per se. The degree of correspondence between the expression and the actual knowledge, or skills, can of course vary, and is to some extent dependent on the depth and complexity of what we want to express.

To some extent, this iceberg can also serve as a metaphor for the relationship between mind and body, where we can acknowledge our body as an essential part of any act of knowing. Polanyi was critical of the Cartesian legacy, which upholds a dualism between the two and where the mind had a superior role, explicitly controlling the body, as if the relation between them were only a one-way street. Think of how the word "I," which equals the mind, refers to something with a disembodied existence, yet situated within our body (Bergo & Hide, 2005). However, neither did Polanyi (1965a) agree with the opposite view, exemplified by Ryle's (2000) description of the workings of the body and the workings of the mind as amounting to the same thing. Polanyi (1965a) believed in the superiority of the mind, but he believed its relationship to the body to be more like a two-way street, where the interaction between them also, contrary to Cartesian explicit interaction, is managed by the logic of tacit knowing.

As we understand, and as Polanyi so clearly shows, this does not mean that explicit objective knowledge is not important. As a scientist, I truly believe that scientific knowledge has an epistemological precedence in that it possesses the potential to achieve a particular truthfulness. Yet the process of knowing is an active, comprehensive process in which I tacitly rely on a set of particulars in the shape of a whole. According to Nonaka and Konno (1998), any knowledge development can be described as a spiraling process of interactions between explicit and tacit knowledge. In all acts of knowing, there is a requirement that I am able to bring my personal participation into this act. As previously emphasized, this personal participation should not be equated with subjectivism, which is unable to take me beyond my

own feelings and assumptions, my own pre-understanding. The personal participation is not a flaw or something I should try to get rid of, but rather a vital component of any act of knowing. This way of thinking surpasses subjectivism because it acknowledges, and aims for achieving, exterior standards or ideals (Polanyi, 1958a). Every process of knowing is, as we understand it then, an intrinsically self-referential process (Korzybsky, 1958, in Scott, 2004, Scott, 2004), where the personal and contextual elements of the process of knowing is always present. In this relation, von Foerster (2003, in Umpleby, 2016) have suggested that we should look at the knowledge-developing process in general, as well as any specific scientific process, from a biological point of view that takes into account the functioning of the human brain. Polanyi`s use of perception as an analogy of the process of knowing, thus, becomes illuminative. In fact, according to Robson (1983, in Varela and Singer, 1987), only about 20 % of the neurones entering the visual structures of the brain origins from the retina, and further that at least 40 % of the neurones comes from the visual cortex. Hence, any visual interpretation that any human being makes is, to a higher extent, dependent on conclusions drawn on past experiences, rather than on current sensations (Maturana & Varela, 1992, in Umpleby, 2016).

Every meaning, concept and knowledge we come to hold is something extracted from our own experiences in whatever context we are situated (von Glasersfeld, 1991, in Scott, 2004). Although our knowledge of the world shares a substantial amount of common features, the brain, to some extent, by its sensory input, constructs any individual`s specific understanding of it (Umpleby, 2016). In the myriad of languages, societies, cultures, religions, educations and jobs and professions, each person`s perspective upon the world therefore, to some extent, is a unique perspective (Ibid). The presence and the power of this personal element advances our conception of science and it has the potential to expand the scientific practice itself (von Foerster, 2003, in Umpleby, 2016). It widens the potential scope of phenomena for the scientific enterprise to embrace by expanding the variety in the reality that is for science to grasp (Ashby, 1952, in Umpleby, 2016). This individualized and unique human component of any process of knowing thus emerges as one fundamental enabling element behind any scientific progress. Hence, it bridges the disjunction between subjectivity and objectivity and opens the door for me to transcend my subjectivity by attempting to fulfill my personal responsibilities to universal standards (Polanyi, 1958a, Husserl, 1997).

Hence, the act of knowing cannot be understood as a random act but must be seen as a responsible act demanding universal validity (Ibid). In a sense, it replaces the anchoring of objective knowledge in pure empiricism or pure logic with a more ambitious anchoring in reason. My own abilities to think, to appraise, to judge, to reflect, to interpret and to understand become essential elements in any process of knowing. My ability to frame ideas or theories that deserve respect in their “own right, by their very rationality” (Polanyi, 1958a, p. 3), or my ability to grasp the essence and to see a rationality within whatever phenomenon I am looking at, becomes vital in itself. Polanyi describes this inner rationality as an inherent quality, something worthy of reaching universal acceptance, and something that has objective standing (Ibid). What is also interesting is that, according to Polanyi (Ibid), to some extent it is by the predictive powers of an idea or a scientific theory, where the implications are not fully known, that objectivity in its deepest form is ascribed to it.

Expanding my horizon

This is not, however, a process of certainty. Any advancement in understanding is moved and guided by my power to see the presence of comprehensive entities behind yet incomprehensible clues. Reaching these hidden meanings can only be achieved by my active foreknowledge of this unknown, but yet accessible, reality. After all, my knowledge is no more than an intimation of the external reality, and in which directions this reality might develop I can never really know for certain (Polanyi, 1961). Any process of knowing hence becomes a pursuit of hidden meanings, which can only be approached by trusting my own intimations of them. Again, this personal aspect of the act of knowing transcends subjectivism, as it is not something I should strive to escape, like a bias, but rather the ultimate standpoint from which it is possible for me to know or to understand anything at all. In fact, it is the only standpoint possible for me to take when I view the world. It is not, nevertheless, a static standpoint. It constitutes my horizon of understanding and it has the potential for continual expansion. The more clues, the more perspectives I can internalize, or at least take into account, in any act of knowing, the more I can see. However, this developing process requires that I am willing to self-transcend, and that I engage in this process, intrinsically motivated for this transcendence (Ibid). Furthermore, this inner drive enabling me to acquire new understanding must never be lost, but merely reduced when I come to hold new knowledge established by this drive. In fact,

it is what makes it possible for me further to develop my understanding within the frames of my own ideas or theories. Every expansion of my horizon of understanding is thus a source for the creation of ever more indications of the world.

To embark on such uncertain scientific explorations demands human qualities of the deepest kind: human qualities, or powers, that we often have suppressed. Polanyi thought of us humans as unprecedented, but in need of restoring the balance of our cognitive powers. The higher power, making it possible for me to come to knowledge beyond what can be demonstrated by observation or proved by logic, is belief (Polanyi, 1958a). In the pursuit of intellectual excellence, in the search for comprehensive entities hidden behind still incomprehensible clues, belief might be my best guide. With belief, Polanyi believes we can recognize and restore our reliance on our own thinking and appraisal as the supreme authority of all intelligent performance (Ibid). Paradoxically, the modern world has condemned belief to such an extent that humans have renounced their own ability to uphold any explicit statement as their own belief. We can, however, again begin to acknowledge belief as the underlying source of all knowledge and that every intelligent operation, every process of knowing, can only be accomplished within such an impetus and such a trustful framework (Ibid).

My whole, unified self is hence placed at the center of my scientific activity, as in my previous description of myself as the most determining element of my scientific conduct. This again opens up another vulnerability and diversity in my conduct. It offers a view of the natural scientist, perhaps resurrects the natural scientist, as a passionate and accountable human being capable of diving into his scientific conduct with a human drive and a personal appraisal of his doings (Polanyi, 1958a). It opens the door to the human personality as a whole, and introduces us to the unity of the sentient, creative and responsible life of human concerns (Zhenhua, 2006, p. 189). It presents us to the idea of natural science as a human practice in its richest form.

Conclusive remarks

In this paper, I, by the aid of Polanyi, have tried to take some substantial steps toward a better understanding of the scientific conduct and the knowledge-developmental process in general. I have emphasized that the notion of a categorical disparity between our knowledge of

tangible and intangible things are outshined. Although diverse kinds of knowledge exist, they are not fundamentally different, but more to be seen as variants of the same kind of knowledge. The composition may be varying, but the sum, whatever it is, is always the same kind of sum. Further, Polanyi's stratified ontology shows us that there is no such thing as purely separable systems. Things are related to other things, and one thing that is a focal objective part at one point, might in the next, higher order, become a subsidiary clue in the comprehension of something else. This notion opens the door to the world's multiplicity and do not close again as the modern science and knowledge doctrine did with its expectations of simplicity, reduction and precision.

In Polanyi's thoughts, every piece of knowledge consists of two varieties, the focal objective part, similar to the modern view, and the subsidiary parts of both personal and contextual origin. By this we also understand that all knowledge has a personal element, an embodied, action-oriented tacit element shaped and developed by our experiences in whatever context of life we are situated. Any person's abilities in coming to knowledge about any subject matter is thus highly dependent on this tacit root. Polanyi also underlines that it is in the act of comprehension that this tacit element best becomes visible. To him any knowledge-developing process is hence a dynamic process of tacitly based comprehension, something best described as a process of knowing. This also implies that there is no such thing as purely external knowledge, something that has an existence on its own. On the contrary, this emphasizes that for something to be regarded as knowledge, it requires to be a dynamic attribute, or effort, of a human being. This view however surpasses sheer subjectivism because it acknowledges, and aims for achieving, exterior standards or ideals.

Polanyi's stratified ontology, and his thoughts about the personal component in any act of knowing, reveals the complexity of the world and the diversity of potential perspectives to view the world from. The personal component discloses ourselves, where we are at this very moment, as the ultimate starting point for anything to come. Consequently, it also accepts our own shortfall and our fragility and human ambiguity as something corresponding to the most beautiful of human life; something modern science with its hunger for certainty and control has tried to deny us. In this whole notion lies an acceptance of my knowledge of the world as some kind of indeterminate, multidimensional, ambiguous and dynamic process of

knowing, since it exactly echoes the complexity and dynamism, and with its even unknown imminent expressions, world itself. Any process of knowing, or any scientific conduct, potentially then, might become a uniting force between my preliminary assumptions and beliefs, my knowledge, of this reality and reality itself. A force that might have the potential to transcend both (Pirsig, 2004). As a scientist, or as a knowing human being, I am not a passive observer of the world, “[I am] part of the world, a fellow player, a fellow being” (von Foerster, 2014, in Umpleby, 2016, p. 459).

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