

The Necessity of Faith for a Successful Scientist and the Necessity of Discovery for a Successful Believer

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Admittedly, religious conversion commits our whole person and changes our whole being in a way that an expansion of natural knowledge does not do. But once the dynamics of knowing are recognized as the dominant principle of knowledge, the difference appears only as one of degree (Polanyi 1958:244).
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Alfred North Whitehead describes the sixteenth century as racked by two great and very different revolutionary movements. The first was the Reformation, which was "a popular uprising [that] for a century and a half drenched Europe in blood" (Whitehead:10). The second was "the beginnings of the scientific movement [that] were confined to a minority of the intellectual elite" (10). Whitehead describes this second movement as more decisive since it was "the quiet commencement of the most intimate change in outlook which the human race has yet encountered" (10). Then he quickly adds a pious footnote: "Since a babe was born in a manger, it may be doubted whether so great a thing has happened with so little stir" (10).

The ideal of arriving at the truth and committing oneself thereto plays itself out within every sector of societal life. How this truth is to be arrived at, however, is another matter. Following in the footsteps of the Enlightenment, the prevailing assumption has been that truth can only be arrived at when the inquiring mind is set free from the restraints of tradition so that an impartial examination of the evidence can sift out the enduring truths from among the confusing diversity of unexamined opinions and dogmatic illusions. Arising out of the ferment of the Enlightenment, the scientific method has claimed that objective and impartial truths can be arrived at and accredited within a community of inquirers without any application of coercion or authoritarian restraint.

Denominations of religion, schools of philosophy, and the varieties of healing therapies cannot claim comparable methods or results. In consequence, the scientific method has gained an exemplary status within modern culture. In the years following Thomas Kuhn's immensely popular, **The Structure of Scientific Revolutions**, those in the humanities have made accelerated attempts to mimic what they understand to be the scientific method for they have been persuaded that "scientific knowledge rests on the bedrock of empirical testability" (Hunt 1991:197) and that the scientific method provides "the most, if not the only, objective mode of pursuing knowledge" (Hunt 1991:200).

Michael Polanyi, in contrast, challenged the ideal of strict objectivism in science as elliptical and misleading.¹ After dismantling various prevailing accounts of the scientific method (as provided by Carnap, Feyerabend, Hempel, Kuhn, Popper, et. al.), Polanyi concluded that "the most inadequate and misleading formulation" could gain acceptance because a practicing research scientist "automatically supplements it by his tacit knowledge of what science really is" (PK:169). In the end, therefore, Polanyi arrives at the position that science itself is "a system of beliefs to which we are committed" (PK:171) and that faith, authority, and tradition form the indispensable foundations for the conduct of every intellectual tradition, science included.

British empiricism and Polanyi's legitimating of embodied knowing

The empirical school of British philosophers took great delight in undermining the reliability of the senses. They did this under the mistaken conviction that physics and chemistry had disclosed the actual nature of reality. According to this norm, the senses all suffer the terrible inadequacy of projecting bodily sensations onto things to which they do not properly apply. The vinegar is not "sour"; the acidic interaction with taste buds on the surface of the tongue simply registers all acids with a "sour sensation." The bottom of the well is not "black"; the absence of reflected light makes any object appear black.

Polanyi allows that all bodily perceptions are projections of interior states but, at the same time, he insists that such projections are spontaneous, necessary, and reliable. Already in **Personal Knowledge**, Polanyi had devised the rule that all knowing relies upon the organismic integration of particulars into self-satisfying wholes. When preparing **The Tacit Dimension**, Polanyi went much further toward explicating the repercussions of bodily indwelling. For our purposes here, the "semantic aspect" of this process is most important:

To see more clearly the separation of a meaning [as the integration of bodily clues] from that which has this meaning, we may take the example of the use of a probe to explore a cavern, or the way a blind man feels his way by tapping with a stick. . . . Anyone using a probe for the first time will feel its impact against his fingers and palm. But as we learn to use a probe, or to use a stick for feeling our way, our awareness of its impact upon our hand is transformed into a sense of its point touching the objects we are exploring. This is how an interpretative effort transposes meaningless feelings into meaningful ones, and places them at some distance from the original feeling . . . (TD:12f).

Polanyi chooses the term "semantic aspect" because he notes that anyone reading or hearing a message projects the meaning arrived at interiorly onto the source of the clues that hold ones focal attention.

Because no two people have the same tacit skills (PK:95-102; Kuhn 1970:191), no two people hear the same thing. When it comes to wolves, they hear a higher range of frequencies and have an acuity a hundred times better than my own. Even when it comes to humans, I am amazed when my auto mechanic listens to my sick engine and immediately declares, "You have loss of compression in one of your cylinders." I also witnessed Seiji Ozawa rehearsing the San Francisco orchestra and suddenly stopping the performance in order to direct attention to an oboe player who came in late and played a B-natural instead of a B-flat. Meanwhile, I had to confess

that what I heard sounded "good" to me.

The same goes for seeing. Persons born blind who, upon receiving an operation, receive their sight for the first time do not see the world as we do (PK:99). This was dramatically portrayed in the 1999 film, **At First Sight**. Virgil, removes the bandages after his experimental operation, and sees patches of moving colors that are confusing and fatiguing. He recognizes nothing, not even the one he loves! In fact, he has to touch things and people he already recognizes in order to painstakingly train his eyes to recognize them visually. This same thing, of course, happens every time a newborn opens its eyes a few days after its birth. This also helps explain why infants require so much sleep. They suffer sheer fatigue at the sensory overload which, as yet, has so few integrated meanings.

Polanyi provides the means to overcome the mind/body impasse that has plagued philosophy ever since the time of Descartes. He does this by restoring faith in our bodies. Sensory and intellectual perceptions routinely rely upon the bodily enhancement of clues, the bodily integration of these clues, and the projecting of the consequent meaning-for-us into the locus where the clues originated. As long as we continue to be embodied spirits, we cannot know things **as they are for themselves**. We know all things **as they are for us** -- bound up within tacit skills that are historically and anthropomorphically conditioned.

How a scientist using a theory resembles a motorist using a map

Going even further, Polanyi provides insight into how scientific observations are theoretically informed. In so doing, Polanyi goes on to provide a solution to the impasse within the philosophy of science as to what extent theories have a bearing upon the reality that exists independent of ourselves.

To understand the heuristic role of theories, Polanyi explores the more familiar case of using maps. Maps, like theories, can only be properly understood when they are in use. When a skilled map-reader consults an appropriate map in order to navigate his car to a given address in an unfamiliar part of town, this is akin to a trained scientist making use of specialized theories for the adjustment of an electronic circuit or the design of an experimental apparatus. Both maps and theories are oriented toward human action and, as a result, the correspondence between theoretical anticipations and practical consequences serves to accredit both the map and the map-user at the same time. This is why only trained scientists can properly use and test theories designed by other scientists.

Maps, like theories, all have a limited scope of application. Each serves to integrate certain clues while leaving the driver entirely blind to others. Thus a truck driver hauling an extra-wide or an extra-high load needs a specialized map designed for his specialized need. In parallel fashion, theories of chemical valence are very helpful in predetermining what substances might combine and in what proportions; yet, such theories are quite blind to melting points or to rates or reaction, to color changes. As a result, a scientist has to have the skill of rightly selecting the "map" that fits the phenomenon under investigation.

The mental indwelling operative in the use of maps/theories is akin to the bodily indwelling that was explored earlier. My auto mechanic who hears loss of compression in one of my car's cylinders while relying upon his tacit powers of hearing then goes on to rely upon his

trained theoretical understanding of how my car works to begin fixing it. My doctor relies upon his own trained theoretical understanding of how my body works when he sets about to diagnose and fix it. The same thing can be said of a nuclear physicist designing an experiment to bombard gold foils with fast neutrons. At no point can any of his/her senses ever detect fast neutrons. In this regard, Einstein is quite correct: **"Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed."** Hence, from beginning to end, the physicist relies upon his/her theoretically informed choice and use of appropriate instruments to extend the power of his/her senses. From beginning to end, the design, the adjustment, the execution, and the interpretation of the experiment are theoretically informed.

The experience of "God" requires tacit powers of knowing

Unlike many other scientists, Polanyi regarded Christianity as having intellectual foundations and inherent worth. Without any religious formation, "God" often remains "an idea," "a projection," or even "a superstition" which others have but which has no relevance or importance "for me in my life" (as in the case of the oracle-poison of the Azande, PK:287-292). After an adequate apprenticeship, however, the tacit powers of knowing and of judging are so transformed that "God" inevitably and stubbornly shows up in expected and unexpected ways during the whole course of one's life. This is what persuades average Christians that "God is alive and well" and that their God meets them and addresses them in their joys and sorrows, their struggles and successes. They call upon the Lord, and he answers them.

But as a child, one does not find either "God" or "radio waves" in the corner of one's playpen. You can't lick or see or twist "radio waves." Same with "God." But, then in a surprising moment, my dad turned my attention toward "radio waves." When? As best as I can recall, we were driving across a bridge and, all of a sudden, the radio program I had been listening to went dead. Once off the bridge, however, the program continued. "What happened, Dad?" Then my dad explained how the steel bridge we had just passed over blocked the "radio waves" from being received by the antenna of our car. I was mystified by this new discovery. From that time forward, I knew that "radio waves" were to have an importance for me if I paid attention to them. And I did. Ten years later, I would build an amateur radio station in the abandoned coal bin of my family home, erect an antenna, and send out "radio waves" that would allow me, in the wee hours of the morning, to communicate with amateurs around the world.

In my parents' home, hardly anything was ever said about God. On Sundays, however, when I turned five, my parents began to take me to church. As a child, I didn't have the least sense of who God was or how s/he was to be found. I did notice, however, that my Dad and Mom became mysteriously quiet as they entered the church. Others did the same. People only spoke in hushed whispers. In this quiet space, something like the following exchange took place:

Aaron: "Hey, Papa, why is everyone so quiet?"

Dad: "Shhhhhh! People come here not to talk but to listen to God!"

Aaron: "But I don't hear anything."

Dad: "Look at that gold box [tabernacle] on the table [altar] at the front of the church."

Aaron: "Oh, it's shiny! I see it."

Dad: "God lives in that little box. The people come here to silently talk to God who lives

there. And God silently talks to them."

This was my first introduction to "God." I realized that my parents sensed the presence of something or someone that I had hitherto overlooked. I was both puzzled and impressed. When I saw the earnest listening written on the faces of my parents as they faced the altar, I tried to join in. I strained to hear God so that I could participate in the act of worship that they enjoyed. After a few years, I developed the practice of silently speaking to "God," and I "heard" God wordlessly speaking back to me. The tacit skills exemplified by my parents and by my teachers, therefore, did eventually become my very own. In fact, God became much more fascinating for me than he had been for my parents. It had been the same way with radio waves.

Yet, what if my parents had given birth to me in India and, during the confusion of an earthquake, their baby son had been separated from them and found and sheltered by Hindu parents who raised me as their own? In this case, I would have witnessed my new parents placing fruit before the image of Lord Krishna each morning and reciting their pujas. Do you think that I would have admonished them for their idolatry and turned their faces toward Jesus Christ? Hardly. Given the bond between parents and their children, Hindu parents devoted to Lord Krishna would have discovered that their son would have assimilated for himself their devotion.

Once established, the tacit powers of knowing shaped by one's acritical childhood upbringing and by one's freely embraced apprenticeships shows up not only in the early formative years but also even in the liminal experiences in the twilight years of one's life. Elizabeth Kübler-Ross and others have documented how, in the case of near-death experiences, Christians frequently meet someone "on the other side" whom they, often enough, identify as a lost love one or even as "Jesus." When medical doctors chronicle such near-death experiences in India, however, they discover that their patients speak of meeting "Vishnu" or "Krishna"--with never a single instance of Jesus showing up. All this goes to demonstrate that, even in the extremities of life when the brain is beginning to shut down due to lack of blood/oxygen, our tacit powers of recognition that one cultivated and cherished during life still are very much in control. This tends to confirm what medieval theologians meant when they said, "grace does not supplant or bypass nature; rather, grace depends upon nature."

Mastery of a tradition

As long as someone has only a superficial acquaintance within any given tradition, such a person cannot expect to plumb its depths or to be absorbed by its practice. In order to gain a mastery of a tradition, however, one must begin by yielding to that spontaneous admiration and trust of someone who exemplifies the tradition one intends to master. The disciples of Jesus, accordingly, are spoken of in the Gospels as leaving behind family and occupation in order to "followed him" (Mark 1:14-20). This Jewish metaphor means more than just going to a local pub for a drink. It means admiring him, staying close to him, watching him, listening to him--all with the prospect of entering wholeheartedly into his way of being and doing and valuing life with his God. This is what Polanyi would describe as an apprenticeship.

Every apprentice who would master an artistic or scientific tradition is required to contemplate reverentially and to reproduce painstakingly the classics for him/herself. Thus, future violinists are apprenticed to perform the concertos of Mozart such that they might

progressively assimilate for themselves the standards of performance and the aesthetic sensibilities which are shared by the living masters who take their stand within the charisma offered by Mozart. In like fashion, future physicists painstakingly reproduce the Millikan oil drop experiment such that they might develop the stubborn perception that the electrical charge is not continuous but increases or decreases in discrete jumps. At the end of an apprenticeship, the novice knows that he/she has arrived by the fact that the classics evoke the same habits of judgment and the same powers of performance that are exemplified by the masters of the tradition.

Within the Christian tradition, the Sacred Scriptures function much in the same way as do the classics in art, music, science, i.e., they serve to evoke and to impose correct modes of feeling and of perception upon a widely dispersed (in place and in time) body of adherents (Dodd:21-29, 32; Milavec 1982:249-252; Newman:75-79; Tracy:115f). The Gospel narratives, therefore, in either their oral or written form, have been used by masters as the preferred vehicle for transmitting the particular charisma and strategy for living that characterized Jesus of Nazareth. Novices within Christianity are led by their masters to contemplate reverentially and to immerse themselves imaginatively into these narratives allowing them to produce the same habits of judgment and the same powers of performance exemplified by their living mentors.

Sometimes parents tell me that they don't want to burden their children by training them in any particular religion. They say, "When they are old enough to decide for themselves, then they will choose." Other parents give their children a bible and imagine that they will read it with profit and the Holy Spirit will guide them without any need of having a mentor.² Polanyi joins with St. Augustine in noting that these attitudes are shortsighted. Augustine remarks that "every kind of scholastic discipline . . . demands a teacher or a master if it is to be acquired" (**De util. cred.** 17.35). With all the greater force, therefore, the "divine oracles" within the Scriptures demand a master if they are "to refresh and to restore souls" (**Ibid.** 6.13).

Scholars such as C.H. Dodd (1962:20f) and Peter Stuhlmacher (1977:60, 87-91) have noted that the Protestant refusal to shackle the intent and power of Scripture within papal or dogmatic confines never meant that the text could properly function outside of the history of its effects within a congregational tradition. Left to oneself, the uninitiated is as incapable of discovering the true worth and function of the Sacred Scriptures as would an inexperienced violinist left alone with the scores of Mozart. Under the guidance of a cherished religious mentor, however, one can rightly come to "taste and see that the Lord is good [and how] happy are those who take refuge in him" (Ps 34:8).

For Polanyi, an apprenticeship requires that a master gradually transform the tacit powers of his/her understudy. In this enterprise, there can be no coercion. Rather, the spontaneous admiration that began the apprenticeship must be sustained during the whole time of the training. Anyone who has a falling out with his/her mentor will stop learning and begin resisting his/her influence. Thus, Polanyi says with St. Augustine, "Unless you have faith, you cannot arrive at understanding."

* In Pentecostal and Charismatic circles, new initiates are customarily offered an intense period of initiation directed toward enabling them to receive the gift of the Holy Spirit as manifested in the speaking in tongues. Once glossolalia has commenced and baptism by the Spirit is confirmed, it can be resumed with greater ease each successive occasion and finally give

way to spontaneous and evocative prayers in plain language as well. Careful studies have shown, however, that those having a falling out with their mentor or pastor lose their ability to pray in tongues and, unless this breach is repaired, they leave their congregation with a sense of shame and disappointment (Kildahl:50, 79; Milavec 1982:31-37). Faith in God, consequently, cannot be securely cultivated in the absence of faith in those persons that have led one to God (Milavec 1982:193-198).

How present intellectual satisfaction inhibits pioneering explorations

Once a given recognition is developed, it positively impedes an alternative. Polanyi called upon simple Gestalt experiments to illustrate this. For example, when the corners of two partially overlapping squares are joined with straight lines, bodily enhancement interprets the resulting design as that of a transparent cube. The letter "A" appears either on the forward or the rear surface or floating somewhere in-between. Once one's habitual tacit skills fix the "A" in one position, it is manifestly difficult to dislodge that perception. One must look away for a while or blink one's eyes in the hope of dislodging the first integration and arriving at an alternative.

While at a picnic, most people will tolerate continuing to eat their food should they discover and remove an ant or a fly on their plate. Should they discover a cockroach, however, most Westerners would be unable to continue eating for they would perceive the food as somehow rendered "unclean" once the cockroach touched it. No amount of rational persuasion would allow a person to change their judgment in this matter. Only a person half-starved might be able to overcome their perception of the food as unclean for long enough to satisfy their hunger. Here, again, once a given recognition is established, it positively impedes every alternative.

The same holds in every field of science. Once the Ptolemaic sun-centered system of the universe was established for over a thousand years, for example, scientists habitually relied upon this theory-informed way of viewing the movements of the stars and planets to guide all their observations. Within the system, it made perfect sense that the stars were made of ethereal matter and executed perfect circles around the earth while rocks and baseballs, being made out of earthly matter, executed straight-line movements toward the center of the universe. At any given moment, someone in Ohio and someone in Beijing could discover where the center of the universe was by releasing a rock. If the rock appeared "to fall down" in Ohio, it would appear "to rise up" in Beijing, or vice versa. In both cases, appearances were deceiving--both rocks were moving toward their natural place, the center of the earth that was the center of the universe. Only a madman like Copernicus could begin to imagine that things were otherwise. In the end, however, even Copernicus was intellectually committed to the Ptolemaic system by virtue of the intellectual satisfaction that system afforded. Even in science, once theory-informed recognitions are established, they positively impede every alternative.

In the end, it would appear that, without any training, a human would live out his/her entire life only marginally different from brute animals (PK:69-71). Once one is trained, however, then it appears that tacit powers of recognition and theory-informed patterns of judgment take over and positively impede every alternative. From this vantage point, every culture, every religion, and every science can appear as a system of indoctrination. Prior to the indoctrination, one sees nothing; following the indoctrination, one sees only what one has been trained to see. This is what Polanyi refers to as the heuristic circularity of every enterprise when

he rightly notes that "our believing is conditioned at its source by our belonging" (PK:322).

At this point, the temptation might be to dismiss all intellectual endeavors as either self-serving exercises in rebellion or as efforts to reinforce the particular groupthink to which one happens to belong. To avoid the mental stupor that results when one systematically denies the validity of all knowing because it may possibly be false, Polanyi puts forward his notion of the "sense of calling" that results in pioneering efforts to make fresh contacts with those realities to which we have been trained to serve (PK:322f). Polanyi thus establishes "the knowledge of an approaching discovery" as the paradigmatic phenomenon that enables the seeker to affirm his/her belief system as more than just an empty ideology:

The pursuit of discovery is conducted from the start in these terms; all the time we are guided by sensing the presence of a hidden reality toward which our clues are pointing; and the discovery which terminates and satisfies this pursuit is still sustained by the same vision. It claims to have made contact with reality: a reality which, being real, may yet reveal itself to future eyes in an indefinite range of unexpected manifestations (TD:24).

In effect, therefore, Polanyi arrives at the position that science itself is "a system of beliefs to which we are committed" (PK:171). While the propositions of science cannot be either properly understood or verified independent of commitment to the system itself, the pursuit of discovery opens up the vista that every scientist functions as a servant that is being led to make fresh contacts with the realities s/he has been trained to admire and to explore.

At this juncture, everything that Polanyi says about the necessity of faith for all learning and about the resistance to change that follows an apprenticeship applies equally to Christianity as it does to physics. Going further, "the knowledge of an approaching discovery" functions as the paradigmatic phenomenon that enables the religious seeker to affirm his/her belief system as more than just an empty ideology:

The pursuit of religious discovery is conducted from the start in these terms; Seek the LORD while he may be found, call upon him while he is near" (Isa 55:6). Thus, all the time we are guided by sensing his hidden presence toward which our whole lives are pointing; and the eruption of God which terminates and satisfies this pursuit is still sustained by the same vision--"Today, if you hear his voice, do not harden your hearts" (Heb 3:8). It claims to have made contact with him: a reality which, being real, may yet reveal itself to future eyes in an indefinite range of unexpected manifestations (TD:24).

Thus, in tandem to what has already been said about science, we can now assert that the propositions of religion cannot be either properly understood or verified independent of commitment within the system itself. By making fresh contacts with the Lord, however, training in Christianity takes on the aspect of being a lifelong service that functions to purify and to enlarge those very commitments that set one on the course to discovering the Lord.

How intellectual passions function when making a fresh discovery

By examining the dynamics undergirding the Copernican revolution, Polanyi finds that he can correct misleading notions of science and properly focus on the process whereby a pioneering investigation is possible even when it takes place within the settled commitments to Ptolemy's sun-centered universe. To begin with, everyone in the fifteenth century acknowledged that something was wrong with the Julian calendar since farmers were painfully aware that the leafing of trees in the spring and the associated spring planting was coming at a later date than ten or a hundred years ago. No one could decide, however, whether the Julian calendar was five or twenty-five days off and, once adjusted, how the calendar had to be corrected so that, in a hundred or a thousand years, it wouldn't have to be corrected again. When this problem was laid at the feet of the experts, the astronomers, they too had to admit that the Ptolemaic system had failed to provide an accurate enough computation of the length of the solar year that would permit the formation of a new calendar. What was to be done?

Copernicus, to begin with, spent years trying to adjust the orbits and epicycles of the Ptolemaic system so as to get a closer fit with the astronomical data at hand. This produced some marginal results, but not enough to recalculate the length of the solar year. Then, taking note that Venus and Mercury never strayed beyond certain well-defined limits from the sun, Copernicus was given over to trying to recalculate the orbits of these planets with their axis of rotation on the sun. A minor improvement was achieved. At this point, let it be noted, the earth was still at the immovable center of the solar system where Aristotle and the Bible said it should be. Copernicus had, as yet, done nothing to disturb the evidence of our senses respecting rocks moving toward the center of the universe. But then, however, in the hope of furthering his correction of the Ptolemaic system, Copernicus decided to try placing the earth and the three outer planets as rotating around the sun along with Mercury and Venus. Eureka!

By fudging with epicycles³, Copernicus was able to modestly reduce the margin of error all around. More importantly, Copernicus was the first one to note that a distinct order was present among the planets--as the distance from the sun increased, the period of revolution decreased. To achieve this gain, however, Copernicus was painfully aware that he had to dislodge the earth from the center of the universe and to treat it as though it were one of the planets making a swift orbit around the sun. This, he well knew, would be laughed at by even the common people since they were all persuaded that the stillness of the air on a lazy summer morning was entirely incompatible with the idea that the earth might be continually rushing nearly 4000 mph in order to make its annual circuit around the sun.⁴ Meanwhile, in 1543, when Copernicus was finally persuaded by Andreas Osiander to allow his work to be published since he was dying, there still was no way of explaining why rocks moved toward the center of the earth even though it was no longer at the center of the universe.⁵

At this point, Thomas Kuhn (1970) is our best guide because he is rightly aware that the first and necessary ingredient for the reception of a pioneering discovery is that some of the members of the community share dissatisfaction with the reigning paradigm and are open to considering an alternative. The "slippage" between prediction and observation must, in Kuhn's view, even generate a "crisis" (an overstatement) before commitment to the prevailing paradigm will be shaken. A community in crisis, however, does not immediately embrace an alternative system that offers some marginal gains at the price of upsetting long-standing convictions regarding the validity of Aristotli an physics. As a consequence, there was a split between those

who continued to stubbornly believe that some solution would yet be forthcoming within the old system and those who committed themselves to perfect and to prove the worthiness of the new system proposed by Copernicus. Since each side of the debate embraced incompatible commitments, there was no neutral ground, no appeals to "common sense," or any experimental evidence that either side could appeal to by way of convincing those who perceived the reality of things from the other side.

The choice [between incompatible theories] is not and cannot be determined merely by the evaluative procedures characteristic of normal science, for these depend in part upon a particular paradigm, and that paradigm is at issue. When paradigms enter, as they must, into a debate about paradigm choice, their role is necessarily circular. Each group uses its own paradigm to argue in that paradigm's defense (Kuhn 1970:94).

Under such circumstances, Kuhn comes to the conclusion that the grounds whereby each astronomer makes his choice are "ultimately personal and subjective; some sort of mystical experience is responsible for the decision actually reached" (Kuhn 1970:199). Hence, since "there is no neutral algorithm for theory-choice" (Kuhn 1970:200), one must wait for the verdict of history to reveal which side of the debate wins out over its contender.

For Polanyi, Kuhn is most unsatisfactory at this point. Polanyi, for his part, was keenly aware that even in science ideological concerns often misdirect the verdict of history. Hence, he began by exploring what Kuhn pejoratively described as "some sort of mystical experience"--namely, the process whereby a pioneering seeker entrusts him/herself to intuitions that guide him/her from beginning to end. Just as faith in ones admired mentors formerly led the novice to discover the depths of the tradition to which s/he is committed; now it is faith in "the gradient of deepening coherence" (Polanyi 1966:88) must be yielded to if the pioneer is to arrive securely into making a fresh contact with those realities that will alter the very commitments that led him/her to undertake the investigation in the first place.

Time and space do not allow for a detailed description of the discovery process. In brief outline, however, Polanyi notes that intellectual passions function spontaneously and reliably at various critical points in the quest for a deeper truth:

1. Initially, pioneering scientists must yield to the lure of a particular problem that attracts them. They must deliberately give themselves over to this problem and to allow it to consume them over an extended period of time.
2. The pursuit of discovery entails a host of critical choices being made along the way. These choices are based upon intuitions that the means/ideas chosen will lead toward an eventual solution. Not to have any guiding intuition in the conduct of research would mean that one would exhaust oneself by endeavoring to "try everything" and encountering "wrong turns."
3. If and when the sought-for solution finally appears, there is an eruption of delirious passion: "I have found it!" The intellectual satisfaction that greets the solution relieves the strains that have been deliberately maintained during the time of the quest.
4. The intellectual satisfaction that led toward the discovery now channels energy toward the publication of the solution. Pioneering scientists inherently

believe that others will come to discover the same satisfaction that they have found. For this to take place, however, the new discovery has to be empathetically received. For a time, it will divide the community.

5. Finally, the intellectual passions attached to the new system enable those who have accepted it to resist criticism and to passionately promote their new understanding (PK:15-174).

Polanyi was entirely dissatisfied with the notion that science progresses because new discoveries are received by scientists who cultivate a detached attitude that somehow allows them to judge the works of their colleagues objectively. Furthermore, Polanyi knew that neither a new nor an old system was dropped as soon as it encountered some experimental data that would appear to refute it.⁶ Rather, for Polanyi, the conversion experience of having been led to make a fresh contact with reality stays with the pioneering discoverer and his allies and persuades them that those who enter into the problem in the way they have done will be progressively led to feel the selfsame intellectual satisfaction that greeted their own conversion. Thus, setting aside the ideal of detached objectivity,⁷ Polanyi maintains that the intellectual passions that undergird every act of discovery are personal without being subjective and are reliable without being infallible (PK:171-173). Just as Polanyi overcomes the philosophical mind-body impasse when it comes to the reliability of the bodily knowing, so too, Polanyi exposes the mistaken ideals of detachment and of logical positivism that disguise from ourselves the reliability of our personal intellectual passions guiding us in the quest for truth.

The history of physics and the development of doctrine

When one begins to examine the history of physics, one discovers two things: (a) that, in the course of history, the community has changed its judgment many times and (b) that, with each change in judgment, earlier theoretical notions were either abandoned or revised/expanded.⁸

Fortunately, major shifts do not happen too often. The fact that they do happen, however, is a testimony to the dedication of its members to the pursuit of truth that goes beyond a mere conformity to the current group-think or to the banal preservation of the tradition as it has been handed down.

When one examines the history of Christianity, one discovers a community whose beliefs have shifted on the basis of prophetic discoveries of the living God. Every deeply committed Christian, in turn, can relate their own personal history of periodic encounters that reshaped their image of God and gave new direction to their lives. A frozen God is dead and a museum piece. Yet, the curious fact that fresh encounters frequently emerge from the depths of contemplation of the Sacred Scriptures gives the impression that, since the classical sources remain the same, nothing has changed. So, too, the doctrine of the immutability of God or of the closure of revelation with the death of the last apostle has often served to enforce the notion that the content of faith never changes and that God always appears the same. One has only to examine the opening chapters of John Henry Newman's classical work, **An Essay on the Development of Christian Doctrine**, or to read a few chapters in Karen Armstrong's, **The History of God**, to discover just how religious self-understanding and orientation toward God has been shaped and reshaped by prophetic encounters.

The changing of the Christian tradition finds ample testimony right within the New Testament books themselves. In every chapter of Acts, for example, one finds evidence of this.

Sometimes the changes are small, as in the case of drawing straws to replace Judas. More significant, however, is the practice of the early community meeting daily in the courtyards of the Temple. Then, Steven emerges saying that "the Most High does not dwell in houses made with human hands" (Acts 7:48). By the time one gets to Acts 10, bold new revelations are being put forward. Near the opening of Acts 10, Peter is praying before lunch and is carried away into imagining a sheet with a mixture of living animals and the command, "Kill and eat." Peter refuses three times saying, "By no means, Lord; for I have never eaten anything that is profane or unclean" (Acts 10:14). Then, by mid-chapter, he says to Cornelius, ""You yourselves know that it is unlawful for a Jew to associate with or to visit a Gentile; but God has shown me that I should not call anyone profane or unclean" (10:29). Two hours later, Peter asks his companions, "Can anyone withhold the water for baptizing these people who have received the Holy Spirit just as we have?" (10:48) Once the first Gentiles are baptized, Peter returns home and one might expect that he would get the heroes welcome. But no! He gets rebuked. "Why did you go to uncircumcised men and eat with them?" (11:3) In effect, these Christians are just where Peter found himself when his noonday prayer was interrupted. Being true to their faith, they confront Peter to his face. Peter, of course, could pull rank saying, "I teach you; you don't teach me." In so doing, however, he would slip into authoritarianism. So, being a wise pastor aware that his faith has shifted, Peter narrates to them in detail his whole history: "Then Peter began to explain it to them, step by step" (11:4). The expectation, of course, is that by evoking the details of his own conversion, Peter will sympathetically draw others to follow him saying, "If this had happened to me, I would have done the same."

Luke does not tell us how successful Peter was. Needless to say, if he had not been partially successful, he would have been immediately ostracized as someone who had betrayed the Lord. On the other hand, we know that he was not entirely successful for he has to repeat his conversion experience again in Acts 15. All in all, Polanyi allows us to notice how prophetic encounters with the living God divide communities and that open persuasion never entirely heals this divide since intellectual passions are alive and well on both sides.

The course of Christian history is shot through with similar encounters. Take the case of Martin Luther, for example. As a young monk, Luther when he was plagued with his sense of his utter sinfulness and overwhelmed by the certainty of the righteous judgment of God. "I can praise God," he would say, "but can he not smell my fear." Then, after a prolonged period of anguish, Luther finally abandoned all his fasting, all his confessions of sins, all his studious efforts to save his soul and was able to let go. And, in letting go, Luther finally fell into the hands of the living God. . . . Following what has come to be known as his tower experience, Luther went on to write and preach based on the intellectual passions that flooded from his fresh understanding of what it means to live by faith. This divided the church and continues to divide the churches to our very day.

In my own life, I, too, have known parallel experiences. It happens about every ten years in my life. Everything can be going smoothly, and then, all of a sudden, I am thrown off my horse. I doubt the worth of nearly everything I have come to be and to do in the name of God, and I surrender to him who knows me better than I know myself. The years following are spent integrating under his guiding hand what I have freshly discovered. With John Henry Newman, therefore, I can say, "To live is to change, and to be perfect is to have changed often" (100). Every mature Christian will understand what I am saying and be able to identify their own string of encounters with the living God.

In the end, the discovery process itself stands as a sober witness that a rigorous and prolonged initiation into physics or Christianity does not function as an impervious indoctrination that renders one's knowing powers immune from discovering anything new. On the contrary, the fact that physicists and Christians do change their minds and do accept what they themselves did not discover stands as a witness that their communities have developed the practical art of tempering the enforcement of conformity with the inducement to dissent. Polanyi thus says:

The discoveries of science have been achieved by the passionately sustained efforts of succeeding generations of great men [and women] who overwhelmed the whole of modern humanity by the power of their convictions. Thus has our scientific outlook been molded. . . . Science will appear then as a vast system of beliefs, deeply rooted in our history and cultivated today by a specially organized part of our society. . . . Such a system cannot be accounted for either from experience as seen within a different system or by reason without any [concomitant] experience. Yet this does not signify that we are free to take it or leave it, but simply reflects the fact that it **is** a system of beliefs to which we are committed and which therefore cannot be represented in non-committed terms (PK:171).

This, of course, could be immediately applied to the Christian enterprise:

Fresh encounters with God have been achieved by the passionately sustained efforts of succeeding generations of holy men [and women] who overwhelmed the whole of modern believers by the power of their convictions. Thus has our religious outlook been molded. . . . Christianity will appear then as a vast system of beliefs, deeply rooted in our history and cultivated today by a specially organized part of our society. . . . Such a religious orientation cannot be accounted for either from experience as seen within a different system or by reason without any [concomitant] experience. Yet this does not signify that we are free to take it or leave it, but simply reflects the fact that it **is** the system of beliefs to which we are committed and can only be affirmed as did Peter, ""We must obey God rather than any human authority" (Acts 5:29) and as did Martin Luther, "Here I stand. I cannot do otherwise." (PK:171).

Verification of novel discoveries in science and in religion

Faced with the distrust of the bodily powers of knowing and distrust of settled authority as a guide to knowing, the Enlightenment endeavored to set up an ideal of knowing that bypassed bodily processes and appeals to authority. Objectification in science takes many forms. Generally it purports to show that science has a sure foundation because scientists accept a new theory only to the degree that it can be shown to be confirmed by experimental testing. Likewise, objectification in religion generally takes the form of securing the foundations of Christianity by demonstrating that the rites and beliefs of a given community conform to what one finds in the New Testament. Both of these expressions are misleading precisely because they endeavor "to relieve us from all responsibility for the holding of our beliefs" (PK:323).

The allies of Copernicus committed themselves to his theory for over two hundred years (a) despite the total absence of any new experimental verification and (b) despite the common sense experience that the earth was motionless. Quakers, meanwhile, came to the realization that "slavery was an abomination before God" in the late eighteenth century (a) despite the total absence of any such declaration in the Scriptures and (b) despite the hundreds of texts wherein the Lord sanctions slavery. Sometimes a new scientific discovery can prompt the acceptance of a new theory; just as the experience of Quakers prompted them to oppose slavery in the name of God. Even in these instances, however, what constitutes a "suitable theory" or "acceptable evidence" always relies upon the paradigm being used. "Verification and falsification are both **formally indeterminate** procedures" (Polanyi 1966:85). Polanyi, accordingly, vigorously objects to objectivism and positivism in all its forms because it removes bodily knowing, human responsibility, and the phenomenology of discovery from the process whereby truth is known in the first place, and, once known, how it is might be revised or disproved.

I shall go on, therefore, to repeat my fundamental belief that, in spite of the hazards involved, I am called upon to search for the truth and state my findings. To accept commitment as the framework within which we may believe something to be true, is to circumscribe the hazards of belief. It is to establish the conception of competence that authorizes a fiduciary choice made and timed, to the best of the acting person's ability, as a deliberate and a necessary choice. The paradox of self-set standards is eliminated, for in a competent mental act the agent does not do as he pleases, but compels himself forcibly to act as he believes he must. He can do no more, and he would evade his calling to do less (PK:315).

The sense of a "personal calling" that grips the soul of a research scientist is not just an empty metaphor for Polanyi for the pursuit of a discovery always begins when a seeker yields to an unaccountable sense that something is not quite right, that something needs looking into, and that s/he is positively drawn to surrender a large portion of his/her life energies to going where no one has gone before. Without surrounding to and intensifying such intellectual intuitions, nothing can ever be discovered.

Conclusion

In the end, Polanyi arrives at the position wherein the human dynamics undergirding the advancement of science have a remarkable parallel to the advancement of religion. Likewise, Polanyi allows that faith and authority are inextricable involved in the transmission of any tradition. Just as one develops a confidence in the use of one's body for riding a bicycle or using a walking stick, so too, Polanyi notes that confidence in the use of maps or the use of theories implies a period of training and a mental indwelling. Theory-informed knowing, however, marvelously extends the body's ability to perceive hitherto unnoticed "realities" and to take them into account in the conduct of one's life. Confidence in our bodily knowing how to ride a bike thus finds its counterpart in our intellectual knowing where and when "radio waves" and "God" show up and how they are to be taken into account. To be sure, "radio waves" cannot be known as they are in and of themselves (independent of a human knower); yet, knowing "radio waves" through human encounters guided by theoretical knowing suffices. There is a continuous gradient, therefore, that links the puzzling disruption of the car radio on the bridge and the use of sophisticated theories and equations for maximizing the transmission properties of my amateur radio antenna. The same thing can be said for God. The transcendent reality of God always

escapes us. God can only be known imminently through human encounters guided by the evocative metaphors and narrative theology assimilated during my religious training. And, here too, there is a continuous gradient between childhood encounters and the complex spirituality guiding ones mature years.

In many circles, scientific affirmations are considered to be strictly impersonal and reliable whereas religious affirmations are automatically denigrated as being subjective and unreliable. For Polanyi, the misleading notion of objectivism in science went on to reinforce defective notions of religion. By correcting how it is that science functions, Polanyi inadvertently arrived at a corrected notion of how religion functions. The physicist and the Christian are thus no longer epistemological strangers--seeking different things using distinctively different methods. Rather they seek different things using remarkably similar methods. As such, a new level of dialogue is ready to begin.

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1. My first love was science. As a boy, I created a fully equipped chemistry and electronics lab in my basement. I experimented with Chlorine gas and fired homemade rockets. In the early hours of the morning, I used my self-constructed amateur radio equipment to communicate with amateurs across the world. Fueled with such a passion for scientific knowing, it was no surprise that I majored in physics in college.

Near the end of these studies, Dr. Rambowski took a personal interest in me and secured for me a post as a research assistant working on flash X-ray photography in his research institute. Then, just as I was getting ready to start, I was amusing myself in the library by paging through past editions of the **American Journal of Physics**. My eye was attracted to an article entitled, "Truth in Physics," by Paul F. Schmidt. This article suggested that all scientific theories were merely mental constructs that could not be demonstrated to have any exact correlation with extra-mental reality. Up to this point, I (being a naive realist) had imagined that electrons, angular momentum, and quarks were precisely what my theories said they were. It had never occurred to me that theories could be just mental conventions that could never really be checked out since there was no way to push our theories aside and to examine nature in the raw.

With this single reading, my faith in physics was bruised. No longer did I have absolute knowledge of the very building blocks of the universe; I just sets of mental constructs endorsed by the reigning group-think within the scientific community. Nothing could be known for certain. And, more importantly, scientists couldn't even know that they were getting closer to "the truth." As a result, I was frozen. The dignity and worth of physics was tarnished in my eyes. It no longer seemed that the pursuit of science was worthy of a lifelong dedication.

As a result, I began reading widely in the philosophy and history of science. Along the way I met Pierre Duhem and Thomas Kuhn. It was only a matter of time before this malaise spread over into my religious beliefs. Now, even the pursuit of God seemed like an impossible quest hopelessly subverted by the human condition. After many years of searching and of anxiety, my soul finally found its rest when meeting with Michael Polanyi. He enabled me fully to appreciate how my religious and scientific calling are quests for truth that are intimately connected and go hand in hand.

2. Polanyi reenforces the imprint of early learning by reminding us what happens to human children who get lost or abandoned in the wild and then, after many years, are found. Two girls raised by wolves in a remote part of Japan, for example, were found when they were five and seven years old. During the nine years these girls lived in a home, they were never able to acclimate themselves to eating with chopsticks or ever able to come to understand or speak Japanese. To the time of their death, they grabbed their food directly with their teeth and howled at three regular intervals every night just as did the wolves who raised them. Japanese culture surrounded them but they were unable to enter in.

3. Neither Ptolemy nor Copernicus had the vaguest idea that the planets followed a slightly elliptical path. Kepler, working some two generations later, was the first to discover and plot elliptical orbits. In the case of Ptolemy and Copernicus, epicycles had to be used on the rims of the large planetary cycles in order to devise a system for how circular movement at a constant rate (as Aristotelean physics required) could be used to situate the planets where the star charts showed they were to be found.

4. The velocity of the earth around the sun is here given using the computations that Copernicus would have made. Copernicus (d. 1543) accepted Ptolemy's calculation that the earth was 8 million kilometers from the sun. No one had any reason to quibble with this figure until the time of Halley (d. 1742) when the transit of Venus was used to determine that the distance of the earth from the sun was something like twenty times what Copernicus and Ptolemy had surmised. In any case, travelling at 40 mph would have been enough to create winds; 4000 mph would have been expected to create gale-force winds.

5. Using the Aristotelean physics popular in the day, the Copernican system would have implied that a rock released on earth would have gone flying off toward the sun (since it was now understood to be at the center of the universe) the moment that it was released. Since this clearly did not happen, Copernicus himself was forced to admit that all astronomers had been misled by Aristotle. In its place, Copernicus theorized that "gravity is nothing else than a certain natural appetite given to the parts of the earth by divine providence . . . in order that they may be restored to their unity and to their integrity by reuniting in the shape of a sphere" (**De revolutionibus** 1.9). In so doing, Copernicus imagined that rocks fell to the earth in order to conform to a spherical shape in the same

way that dew drops naturally reconstituted their spherical shape when disturbed. He was later to be proved entirely wrong in this surmise; however, this only shows that Copernicus felt the intellectual need to present some alternative to Aristotle's doctrine of "natural place" if his new doctrine was to be given any hearing at all.

6. How about stellar parallax? Think of an automobile on a dark road. . . .

7. Accordingly to Polanyi, various schemes have been adapted in order to accredit things as true independent of the believer. Such schemes, however, only reveal how the reliability of our knowing organism and of the discovery process have been devaluated and dismissed. Thus, even the notable philosopher of science, Ian G. Barbour claims that "by the [early] seventeenth century Copernican astronomy was widely accepted [because] the scientific evidence was by then indisputable" (**When Science Meets Religion**, p. 45). Barbour here erroneously anticipates the first experimental evidence of stellar parallax (Bessel, 1838) and of the earth's rotation (Foucault, 1851). He fails to recognize that Copernicus had to be accepted as true in order that some astronomers would have spent years seeking for experimental evidence confirming the commitments that they had already made on other than experimental grounds. Polanyi does allow that experimental verification does play a role in science; yet, he is a sharp critic of those who imagine that nothing is accepted by scientists unless it has a prior experimental verification. In effect, Polanyi says: "Objectivism seeks to relieve us from all responsibility for the holding of our beliefs. That is why it can be logically expanded to systems of thought in which the responsibility of the human person is eliminated from the life and society of man" (PK:323).

8. Electricity, for example, was first thought to be static and to have two distinct varieties. Then with the discovery of the battery, it was necessary to think of an "electrical fluid" that "flows" in metal conductors. Benjamin Franklin persuasively argued that, instead of two kinds of electricity, there was, in effect, only one kind and that it flowed in wires from the positive pole (that had a surplus of electrical fluid) to the negative pole (that had a deficiency). Later, thanks to the efforts of men like Robert Millikan, the electron was isolated giving rise to the conclusion that electricity came in discrete bundles of negative charges that moved within conductors from the negative to the positive pole of batteries. Then, with subsequent explorations, the bundles of negative charges were associated with a discrete particle that had a mass, a spin, and an angular momentum. In each of these steps, the reality being pursued showed itself in new and unique ways and, in each step of the way, dedicated seekers submitted their energies in order to follow their research wherever it would lead them.