

**Re-Thinking the Machine Metaphor since Descartes:
On the Irreducibility of Bodies, Minds and Meanings**

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Abstract: Michael Polanyi's conceptions of tacit knowing and emergent being are used to correct a reductionism that developed from, or reacted against, the excesses of several Cartesian assumptions: (1) the method of universal doubt; (2) the emphasis on reductive analysis to unshakeable foundations, via connections between clear and distinct ideas; (3) the notion that what is real are the basic atomic substances out of which all else is composed; (4) a sharp body-mind substance dualism; and (5) the notion that the seat of consciousness can be traced to a point in the human body. The reductivist project in biology began with the emphasis Descartes put on the body as a machine. Michael Polanyi re-appropriates the machine metaphor to demonstrate how mechanistic explanations are not fully reductive. He shows how an eliminative materialism that would reduce mind to brain is unwarranted if either an interlevel mechanistic reduction or an intralevel successional reduction is posited.

Key Words: Cartesian dualism, mind-body problem, intentionality, tacit knowing, emergentism, eliminative reductionism, biology, cognitive science.

According to Michael Polanyi's philosophy of science, both knowing and being display parallel structures that belie reduction to completely explicit components, and both are intimately intertwined. Understanding them, and their interconnection, allows us to correct little mistakes of excess that, according to Polanyi, can have far-reaching and dehumanizing consequences.

The little mistakes about knowing and being I am concerned with here reach far back in the history of science, at least to Descartes, but they reached their height of influence in the positivist conception of science that Polanyi criticized. Little mistakes can magnify and become dangerous. Polanyi witnessed a time when positivist conceptions were seeping into culture. Since science came to be seen as the proper test of all truth—even in domains well beyond its scope—the dangers of these excesses spread well beyond the enterprise of science. Polanyi saw this "scientism" in top-down totalitarian institutions and in central-planning for science itself. He also saw how scientism could undermine a person's belief in his or her own agency and in the reality of human meanings and values. In radical but not unrepresented forms, scientism can even lead one to reject the existence of mind, mental states, and thoughts.

Both Cartesian substance dualism and a misunderstanding of the role of analytic reduction in science are the results of little mistakes with large consequences that Polanyi endeavored to correct. With the successful advances of physics in the 19th century, a wave of reductionism reached through the natural sciences (Woese, 174). Biology was a last holistic holdout. With the conception of a living organism, it held fast to teleological principles and higher-level explanation. But in the middle of the 20th century it seemed that biochemistry would undermine the independent interests of the organism. And if reductionism could wash over biology, then it seemed human meanings, too, would be washed away. Meanings would reduce to mind, mind would reduce to body, and body would reduce to matter in motion. The tide would recede leaving only so much sand in its wake.

The major contributions Polanyi makes in bolstering biology against reduction, and in securing an independence for bodies, minds and meanings are captured his understanding of machines. Since Descartes, the conception of the human body as a mere machine was used as to illustrate and advance a reductionist program. Polanyi reverses this idea. The human being *is* like a machine, but this instead shows we are indeed *more than* the sum of our parts. He uses the machine analogy as an *anti*-reductionist strategy to show how the mind can both be a matter of bodily functions and also something more.

I will begin by telling a story about the rise of the machine metaphor and how that picture, together with a few little mistakes, came to undermine confidence in the existence of the mind above and beyond the workings of the body. After providing the context in which mind-body dualism is ultimately suspect and eliminative reductionism seems warranted, I will present Polanyi's picture of the ineliminability of the tacit in knowledge, the irreducibility of emergent levels in ontology, and how both combine to show the irreducibility of mind to physics and chemistry. Polanyi emphasizes analytic reduction as a *method* of scientific investigation but introduces two new dualisms (subsidiary-focal attention & dual control systems) that guarantee epistemological and ontological irreducibility for some systems. Correcting Descartes mistakes brings a new way of looking at machines.

Mind-Body Dualism in the Age of Analysis

The Modern age is said to have begun with Descartes. By cleanly separating spirit from matter into two separate substances, he initiated an investigation into nature that looked for mechanical causes for all physical phenomena. We learned to account for the motions of animals without the animation of a spiritual substance. The bodies of animals and the bodies of humans were simply machines (Descartes, 73). Descartes appealed to physical laws and not the soul for the motions of the body. The body was divisible into parts and these parts explained sensations: "when I feel pain in my foot, physics teaches me that this feeling is communicated by means of the nerves dispersed in the foot" (165). Like a clock, with its wheels, springs (75), hands and chimes, the parts worked together to explain all we could see, hear and otherwise sense.

This approach advanced science tremendously, but eventually became a threat against the very existence of soul or spirit that Descartes overtly attempted to protect. As spirit dropped out of the explanation more and more, it became a useless appendage, a supplementary nothing. Our minds and thoughts became seen as the result of physical processes rather than as evidence of a spirit that existed independently of the flesh. But we still had our minds, if not our souls, and could thus seek to sustain the more ephemeral, yet commanding, half of the dualism.

In the continuing march of science, however, it appeared that we were beginning to lose our minds. The idea of the living organism as a machine became a threat against our conception of the mind as an active and controlling principle of the body. As explanations became carried more and more by material and efficient causes, mental states

and thoughts became mere epiphenomena; the real wheels and springs were the chemical and physical processes. Not only was the human spirit banished from the human body, but the human mind was nothing more than the ticking and clanging of parts. Meanings were lost; loves and hopes became illusions riding on hormones and endorphins.

By the mid-twentieth century, at the height of the influence of analytic philosophy in understanding science, it looked as if all that we valued as human beings would be dissolved into mindless, soulless fragments: the body is *only* a machine—reductionists charged, echoing Descartes—and there is no ghost in the machine.

But the old conception of soul as completely separate from body was wrong to begin with, and it sent us down the wrong path. The conception that minds and other emergent features of the world are illusory also grew out of that same wrong picture.

Three Little Mistakes about Knowing and Being

Descartes' "mechanistic philosophy" took hold of the scientific imagination. But why this impetus to see the machine metaphor in a reductionist light? That is where little mistakes about knowing and being come in. Polanyi's philosophy attempts to reverse three interconnected mistakes of excess in Cartesian thinking that have led to misunderstandings in how science is done, how we know, and what we are.

Descartes' method of inquiry began with universal doubt. He claims to doubt everything in order to trace knowledge back to unquestionable building blocks. The wax of the candle might melt into a different shape, what I experience by the fireside might be a dream. What we commonly encounter as realities might be illusions. So the first little mistake was an emphasis on doubting what we actually experience, i.e., the starting points for our exploration of knowledge. Polanyi corrects this excess with his emphasis on personal knowledge. There is always a background of tacit commitments at work in our understanding and it is impossible to question all knowledge at once in an arbitrary act of hyperbolic universal doubt. It is impossible to find completely objective starting points that are untainted by human values and commitments. We begin with our commitments in hand, which we may then refine.

Descartes' second little mistake is also epistemological. He assumes that all knowledge can be made perfectly explicit and analyzed down to perfectly explicit components. Descartes strove to provide us with certain knowledge both by emphasizing clarity and distinctness in our ideas and by using the model of his creation, analytic geometry, as a paradigm for acquiring secure knowledge: any piece of complex knowledge could be both mathematized and analyzed down to a few basic axioms that describe the components and the rules that govern their combination. A reductive analysis became seen as the right way to gain a secure foundation for knowledge. Polanyi corrects this excess with his conception of tacit knowing: all knowledge is founded on tacit background knowledge which can resist a complete analysis into clear and distinct components.

This Cartesian mistake of excess sets the stage for epistemological assumptions that Polanyi finds in the logical positivists, but it also greases the slide into a third mistake of excess, since *how we know* is seen to be structurally similar to *what we know*. The biggest little mistake, it turns out, is a metaphysical mistake regarding being. It predates Descartes and may go back to Parmenides and the pre-Socratics, who sought to explain our experience in terms of a more fundamental reality, be it *the one*, water, earth, air, fire, love, aversion or some combination of elements and forces. It is the mistake of believing that the most objectively real things are the *basic substances* from which all else might be composed *together with their properties*, which are displayed in the laws of relation which govern them.

This third mistake rises to prominence in Descartes and the new sciences of Modernity. It gains new force and momentum in the context of universal doubt and with the success of reductive analysis. We can see it raise its head clearly from the shadows in Descartes' ontological argument for the existence of God. Descartes says, "Now it is manifest by the natural light that there must be at least as much reality in the efficient and total cause as in its effect; for whence can the effect draw its reality if not from its cause?" (119) Polanyi corrects this metaphysical mistake with his conception of emergence: entities and properties that *come after* or *rely on* some other more basic substance can be just as real, or even more real, than that upon which they rely.

We can see Descartes' mistakes implicit in some current physicalist accounts of the mind. In response to the claim that mental properties are real and emerge from "the organizational achievements of physical matter," Paul Churchland says, "if that is how mental properties are produced, then one would expect a physical account of them to be possible. The simultaneous claim of evolutionary emergence and physical irreducibility is *prima facie* puzzling" (1988, 12).

The puzzlement comes from the expectation that a "physical account" will be a fully reductive account of emergent things and their properties to components, rather than an account that assists us in understanding necessary conditions and mechanistic causal relations operative in an emergent system. This expectation is a remnant of the little mistakes: (1) the doubt about that which we do directly experience, (2) the hope in a fully reductive analysis to unshakeable components in knowing, and (3) the confidence in a correlative full reduction of any experience to more rudimentary components of simple being.

The mistake of reductionism in science is not in the pursuit of components and relations. The mistake is believing as Descartes did that "substances" have "more objective reality" than their effects, which were mere "modes or accidents" (Descartes, 119).¹ The mistake is to believe that only the causal conditions identifiable at a lower level are in the domain of the real, and all else is less real, or just an illusion concocted by our senses. As Marjorie Grene says, "it is only the smallest, invisible parts of things that alone are allowed to count as 'real'. Only an atomistic metaphysic, it seems, is *no* metaphysic, but a defense of phenomena against metaphysic" (24).

Real things can indeed be taken apart—irreducibility does not entail indestructibility—and when this happens the properties attributed to the system can cease to exist, but that does not mean that those properties and that entity were not real. Polanyi advocates reduction and analysis as a methodological tool. He believes that proper explanations will require higher-level as well as lower-level approaches, and while lower-level entities and their relations are required as necessary conditions for the functioning of higher-level systems, not all systems can be ontologically reduced to their components.²

Polanyi deploys the machine metaphor to correct misconceptions about the reduction of our being, and to show how we might conceive ourselves free to operate by different, higher-level laws and meanings. But in order to understand his conception of the machine, we first must understand how we know meaningful things.

Personal Knowledge and Scientific Analysis

Polanyi advanced a conception of *personal knowledge*, as opposed to a strictly objective knowledge or a merely subjective knowledge. This conception arose from Polanyi's self-understanding as a scientist. He saw that actual scientific knowing was being distorted and misconceived into a duplicitous scientism.

Polanyi saw the positivist ideal of *completely* objective knowledge—purified of human meanings and commitments—as culturally destructive and false. Properly understood, there is nothing wrong with scientific analysis: "...analysis and integration leads progressively to an ever deepening understanding of a comprehensive entity" (*KB*, 125).³ And, properly understood, there is nothing wrong with explicit formalization and mathematization of knowledge either. "Formalization of tacit knowing immensely expands the powers of the mind, by creating the machinery of precise thought" (157). But a proper understanding puts these scientific tools in the context of the higher-level meanings encountered in human experience: "...we can use our formulas only after we have made sense of the world to the point of asking questions about it and have established the bearing of the formulas on the experience that they are to explain" (179).⁴ The project of logical positivism boiled down to an effort to formalize scientific knowledge and reduce it to axioms and laws about atomic constituents. But for Polanyi, "the original intention of logical positivism ... to establish all knowledge in terms of explicit relations between sensory data" was a chimera (156).

There is nothing wrong with attempting to discover the underlying physical processes, but a reductionist approach can discourage us from seeing emergent entities from the higher-level perspective of meaningful experience. As John Dewey said about ordinary, primary experience, *this* is the level where the interesting questions arise; it is the place from which we start our investigation and to which we return for the results to be significant.⁵

Polanyi worried about the attempt to reduce all domains of scientific knowledge to physics. I believe he saw this as a stage in a corrosive undermining of human meanings and values. Polanyi was especially concerned that biology and the human sciences were being mesmerized by this false ideal of true knowledge as mathematized, atomized and purified of human meanings. Biology in its "physics envy" was losing sight of the fact that to explain everything in terms of biochemistry and physics dissolves the very subject matter it seeks to explain and alienates us from our actual experience of the world as meaningful.⁶ While Polanyi appreciates scientific analysis and formalization, he also warns that "any attempt to gain complete control of thought by explicit rules is self-contradictory, systematically misleading and culturally destructive. The pursuit of formalization will find its true place in a tacit framework" (KB, 157).

So what is this framework of tacit knowing that helps assure us that higher-level meanings actually can apply to the things we experience?

Tacit Knowing: The Irreducibility of Meanings and Meaningful Things

According to Polanyi's structure of tacit knowing, our conscious attention moves *from* subsidiary "clues" *to* a focal meaning or object. A variety of clues are synthesized into a joint comprehension of meaning that is more than a simple sum, and each joint comprehension can become a clue to a further synthesis. This movement is the *from-to* or *from-at* trajectory of intentional awareness. In this process, the clues themselves are at best noticed marginally. Most get submerged and escape awareness. Polanyi sees this general structure in many sorts of activities that count as knowing. Understanding a passage from Shakespeare, playing the piano, and seeing a three dimensional object all display this structure of tacit knowing.

A simple example of Polanyi's paradigm can be drawn from linguistic comprehension. When we *attend to* a word on a page we *attend from* the particular letters, e.g., "c", "a", and "t", as clues to the word, "cat". When we *attend to* the meaning of a sentence, we *attend from* the words, e.g., "the", "cat", "is", "on", "the", and "mat", and their organization. Likewise, when we *attend to* the meaning of a paragraph we *attend from* the sentences and their organization. The reason we are poor proofreaders of our own work is because we focus ahead on the meanings while the letters, functioning tacitly, become virtually invisible to us.

When we do focus on the letters and *look at* them, we do not see them in the same way as we do when we *look from* (or through) them *to* their joint meaning in a word. Likewise, we do not see the individual words in the same way when we *look at* them individually as we do when we *look from* them *to* their joint meaning in a sentence. And so we might find an individual word ambiguous outside the context of a sentence.

Many of Polanyi's examples of tacit knowing show how the *clues to a joint meaning* are also the *parts of a comprehensive whole*. Some examples are: "(1) The understanding of physiognomies, (2) the performance of skills,

(3) the proper use of sensory organs, and (4) the mastery of tools and probes" (*KB*, 128). In this family of analogous structures a set of particulars is related to a comprehensive entity. By using examples from many fields of knowing, Polanyi shows how this rough, general from/to structure of knowing covers how we understanding meanings and also how we perceive objects.

Polanyi's epistemology and ontology blend together here because *how we know* is through tacit clues, but the parts and context of *what we know* are also our clues to the things we experience. His is an epistemology when it comes to emergent beings: knowing and the experience of being are intimately intertwined; we experience objects as meaningful joint comprehensions.

In cases of tacit knowing, Polanyi says, "The essential feature throughout is that particulars can be noticed in two different ways." We can notice them "*subsidiarily in terms of their participation in a whole*" or we can "be aware of the particulars *focally*" (*KB*, 128). When the particulars act subsidiarily, they are tacit clues to the focal entity. When we are aware of the clues focally, we lose sight of the whole towards which they contribute. Polanyi stresses that there are two different *kinds* of awareness operative here, not just two different *degrees* of awareness. Shifting from one kind of awareness to another operates like a gestalt switch, one can see the rabbit *or* the duck, or the vase *or* the profiles, but not both. Similarly, one can see the ink lines or the drawing of the duck. When attention shifts to the parts, the joint significance the whole is disrupted. And when attention is directed to the whole, the parts recede into the tacit dimension.

This dualism of subsidiary-focal awareness is a feature of our machinery for understanding meaning and experiencing objects. Because we always rely on tacit clues for our focal knowledge, knowledge cannot become completely explicit. Knowledge (like a skill) can be deepened by analytic breaking down of theory (where the joint comprehension or meaning of the data is no longer in focus) and a synthetic reformulation of theory (where the data can once again be ordered and understood in terms of a new theoretical picture).⁷ But tacit clues can never all be made completely explicit for two main reasons: "First" says Polanyi "there is always a residue of particulars left unspecified" and "second", Polanyi continues, "even when particulars can be identified, isolation changes their appearance to some extent" (*KB*, 124). We don't know when we've captured all the relevant clues, whether they be parts that contribute to the meaning of an object as a whole, or whether they be contexts, greater wholes, from which we understand a focal object as a part. When we focus our attention on these clues they do not perform the same function as they do when we attend *from* them as clues *to* the focal thing. The intentional *from-to* structure of knowing brings a third way in which the clues that go into an awareness cannot be fully specified: when we *attend to* the clues, we are also inevitably *attend from* yet other set of clues which are tacit in relation to what we now have as our focal knowledge.

There is always a tacit dimension to knowledge that we cannot completely eradicate. This is not just a matter of the complexity of the phenomena we choose to investigate, but a feature of the way we know, and also, for Polanyi, a

feature of reality itself—reality itself is indeterminate and cannot be fully specified; if something is real, it can show itself in surprising ways. The real is not identified with the most basic source of all; the real is what "may reveal itself to our deepened understanding in an indefinite range of unexpected manifestations" (*KB*, 133).

Apprehending the Emergent Mind

The structure of tacit knowing that integrates clues into a joint meaning, i.e., a *joint comprehension*, is similar to the structure by which we know a *comprehensive entity* by its part and effects. For Polanyi there is a structural similarity between *how* we know and *what* we know: Knowing a comprehensive entity is done by dwelling in its parts/particulars as tacit clues to their joint significance, which is recognized as real. All knowledge is indwelling in subsidiaries that then present us with a focal gestalt, and "[s]cientific knowing consists in discerning gestalten that indicate a true coherence in nature" (*KB*, 148).

Polanyi sets up the analogy: Just as there are joint comprehensions of meaning that are not reducible to their clues, so there are emergent entities that are not reducible to their parts, and the laws which govern those parts. For Polanyi, this irreducibility to subsidiary clues is not just a matter of *our knowing* but of *what we know*.

For instance, we know the mind of another person through his or her intelligent behavior. By dwelling in bodily clues we come to see a comprehensive entity. By dwelling in the moves a chess player makes on the chessboard, one can come to identify a strategy as a higher-ordering principle. Similarly, one can gain insight into the mind of a person by watching and integrating his or her behaviors. "Chess players enter into a master's thought by repeating the games he played. *We experience a man's mind as the joint meaning of his actions* by dwelling in them from the outside" (*KB*, 152). The intelligent bodily actions and meaningful sentences of a person act as clues to the mind.

From this perspective, we can see that although the mind is the meaning of the body and its behaviors, for Polanyi, it is not fully identified with the body or its behaviors. This is so just as the words are not fully identified with the letters, and just as the real thing is not the same as the material sign that point us toward that thing. This approach shows the failings of a reductive analytic behaviorism. Polanyi says, "Ryle's conclusion that the workings of the mind *are* the mind, is like saying that the word 'table' is a table" (*KB*, 169).⁸

In seeing the mind as the meaning or joint comprehension of bodily clues, we can see the dependence of the mind on the body, just as a whole is dependent on its parts. But what reason do we have to believe that the mind that we recognize as a gestalt of bodily clues is indeed a true coherence in nature as well? Furthermore, what reason do we have to believe that the mind gains freedom and is not merely determined by lower-level laws?

Polanyi says, "We can see that, though rooted in the body, the mind is free in its actions—exactly as our common sense knows it to be free. The mind harnesses neurophysiological mechanisms; though it depends on them, it is not determined by them" (238). Polanyi shows how minds can be real and exercise freedom by talking about machines.

Emergent Being: Dual Control Systems

The machine metaphor has been employed by reductionists to undermine the belief in the separate existence of the mind, and thereby to eliminate the spiritual substance of Cartesian dualism. Pointing out how the organism is like the soulless machine by providing a mechanistic explanation of its functions was thought to be enough to advance a reductive physicalism. Anti-reductionists, such as Hans Driesch, thus felt compelled to defend an idea of organisms in opposition to a conception of machines (*KB*, 232). Polanyi, however, re-appropriates the machine metaphor to show how it supports an irreducibility.

My analysis of machines and living beings entails the rejection of Ernst Nagel's [1961, *The Structure of Science*] claim to describe machines and living beings in non-teleological terms. Nothing is a machine unless it serves a useful purpose, and living organs and functions are organs and functions only to the extent to which they sustain life. A theory of knowledge based on tacit knowing does not require that we purify science of references to mind or to the finalistic structure of living beings (*KB*, 157).

Polanyi uses the understanding of a machine to re-establish a certain form of dualism; one in which a higher-level system or entity can operate on the boundary condition left open by a lower-level system. Polanyi says, "the physical sciences expressly leave open certain variabilities of a system, described as its boundary conditions. The operational principles of a machine control these boundaries, and so they do not infringe on the laws of physics and chemistry, which operate within these boundaries" (*KB*, 154). Polanyi does not deny that atoms in the void and their laws are necessary features of thoughts and decisions, but he takes the "mere" out of the metaphor that we are "mere machines".

When we look at a machine, "The particulars viewed in themselves are controlled by the laws of inanimate nature; while viewed jointly, they are controlled by the operational principles of the machine" (*KB*, 154). Lower-level particulars, and the laws that govern them, form one control, but in a machine there is "multiple control". Higher operational principles also exercise control, and these are displayed by laws of engineering.

A class of machines is "characterized by the operational principles of the machine, including the principles of its structure", i.e., the sort of principles that you must specify in order to be eligible for a patent (*KB*, 175). Polanyi uses the example of steam engine. "To define a steam engine is to tell in what ways it utilizes the laws of thermodynamics and other laws of physics and chemistry. That is why these principles are part of the distinctive science of engineering. Engineering deals with principles of technical success, and hence can also identify technical failure, as in broken down steam engines" (*KB*, 176).

A broken down steam engine still obeys the laws of physics and chemistry –the lower-level controls still hold—but it no longer satisfies the higher-level operating conditions. Thus Polanyi shows how the higher level cannot be reduced to the lower level; the conditions which count as success or failure are provided by the higher level and are unrecognizable simply in terms of the lower level.

In "Life's Irreducible Structure", Polanyi shows how DNA is not simply reducible to molecular biology. If a living being has DNA, according to Polanyi, then it already displays dual control. Every dual control system "restricts and orders, in the service of conveying its information, extensive resources of particulars that would otherwise be left at random..." DNA exhibits dual control because it acts as a "blueprint of the growing organism" (*KB*, 230); it works as a code, selecting from multiple possible variations in order to engineer the developing organism.⁹

Instead of a single divide between matter and spirit, Polanyi's ontological dualism contains multiple levels of dual control, and the higher is dependent on the lower levels for its necessary conditions: "...each level is subject to dual control: (i) control in accordance with the laws that apply to its elements themselves, and (ii) control in accordance with the laws of the powers that control the comprehensive entity formed by these elements" (*KB*, 233).

Living systems, like machines and language, also display a hierarchy of dual controls:

All living functions rely on the laws of inanimate nature in controlling the boundary conditions left open by these laws; the vegetative functions sustaining life at its lowest levels leaves open, both in plants and animals, the possibilities of growth and also leaves open in animals the possibilities of muscular action; the principles governing muscular action leave open their integration to innate patterns of behavior; such patterns are in turn to be shaped by intelligence, and the workings of intelligence can be made to serve the still higher principles of man's responsible choices (*KB*, 155).

These higher levels of organization are not reducible to the lowest level and its laws. Polanyi says, "to reduce this hierarchy to ultimate particulars is to wipe out our very sight of it" (*KB*, 236). We can, however, understand more about the operations of these various levels by engaging in an analytic investigation of a system's mechanisms.

Through a person's intelligent behaviors we recognize his or her mind; this apprehension involves the *from-to* structure of knowing. We also know an emergent entity by dwelling in its parts. Polanyi says, "The logical structure of tacit knowing covers in every detail the ontological structure of combined pairs of levels" (*KB*, 218). It is therefore likely that the mind we know by dwelling in the bodily actions of another person is real. Especially since we can affirm the reality of our own minds through similar clues, and we can experience our own agency over the boundary conditions of our bodies.¹⁰ But focusing on the parts destroys integration to a meaningful whole. This fact about our intentional awareness encourages both Cartesian dualism *and* eliminative materialism. Polanyi shows why it is easy to think we are losing our minds when we examine our brains.

Correcting Cartesian Substance Dualism with Polanyi's Dual Dualisms

Current eliminative reductionists explicitly reject Cartesian dualism, but they are actually engaged in picking one horn of the dilemma that Descartes put out for them. They pick the physicalist horn because the other comes to look like "spooky stuff" (Churchland, 1993, 23). Descartes' little mistakes of excess assisted in solidifying a much bigger mistake: that of a strict dualism between physical and mental substances. This dichotomy is the result of misunderstanding the real dualisms at work for Polanyi: those between subsidiary and focal attention, and those of dual control in certain physical systems.

Focus on the clear, distinct and explicit, takes attention away from the tacit background. According to Polanyi, the mind is emergent and real, but misunderstanding how the mind relies on tacit subsidiaries to experience things brings us naturally to misconstrue the relation between body and mind. We are inclined to see the focus as an independent object standing apart from us, but not to see the tacit background within which we dwell; we see the joint meaning, but not the tacit parts.

The mind-body problem arises from the disparity between the experience of a person observing an external object, e.g., a cat, and a neurophysiologist observing the bodily mechanism by use of which the person sees the cat. The difference arises from the fact that a person placed inside his body has a *from*-knowledge of the bodily responses evoked by the light in his sensory organs and this from knowledge integrates the joint meaning of these responses to form the sight of the cat; whereas the neurophysiologist is looking at these responses from the outside has but an *at*-knowledge of them which, as such, is not integrated to the sight of the cat (*KB*, 238).

The neurophysiologist is looking *to* or *at*, that which we normally look *from* as tacit bodily clues. In perception there are subtle muscle and nerve reflexes that operate subsidiarily that we can't even feel, but which we use subsidiarily as tacit clues. But to look *at* the clues, we alienate ourselves from their joint meaning and objectify *those former clues* as focal objects. To look merely at the physiological clues that present us with the mind is to obscure our view of the mind. Polanyi says, "the mind is the meaning of certain bodily mechanisms; it is lost from view when we look *at* them focally" (238). A sharp substance dualism is encouraged because "we can distinguish sharply between the mind as a *from-to* experience and the subsidiaries of this experience, [which] when seen focally, [are seen] as a bodily mechanism" (238).

Aiding in this illusion of a disconnection between the body and mind is the invisibility of the bodily clues when they perform subsidiarily to present focal experience. In the movement *from* tacit clues *to* a focal meaning or object, there is also what Polanyi calls a "vectoral" quality (*KB*, 141). We are transported from the clues to the focus in such a way that the clues become "transparent". When we use a probe, for example, we are not aware of the pressure on the hand, the tension in the muscles, the signals to the brain, but we experience what is at the tip of the probe. With proficiency we no longer even recognize the clues we rely on, until, perhaps, a breakdown at some point forces us to make the tacit operations explicit.¹¹ Since many of the operations behind our experience of the world and our

thinking rely on tacit subsidiary structures, a whole dimension of our being appears to be invisible, but when we look *to* those subsidiaries, their meanings disappear.

We can thus see how the conception that spirit or mind is completely distinct from the body can come from an inadequate understanding of the tacit dimension of our knowing and perception. Both the notion that mind is mere epiphenomena or illusion and only matter exists, and the notion that the physical world is *maya* or illusion and only mind exists stems from that same inadequate understanding. The epistemological dualism between subsidiary and focal awareness encourages a substance dualism; a view that either ignores the comprehensive meanings and focuses on the existence of brain as the physical entity that we can *look at*; or a view that ignores the subsidiary physical clues and focuses on the existence of a mind as the entity we can *look from*.

The mind that we perceive in another person is the higher-level control in a dual control system. In our experience of other minds and our own, the tacit structures operate invisibly, and so the mind itself is likely to be understood as something that does not rely on these material structures. But, contrary to Cartesian mind-body dualism, the experience we have of a mind is indeed dependent on these subsidiary physical clues. And the existence of the mind as an entity is similarly dependent on subsidiary physical conditions. The relation of the mind to the body is one of dual control. The lower-level provides necessary subsidiary conditions, but the mind can act upon the boundary conditions left open at the lower level.

Correcting the Role of Reduction with Polanyi's Dual Dualisms

Some antireductionists make emergentism a weak claim that is often satisfied and make reductionism a very strong claim. This is one way to bolster an ontological antireductionism. Although William Wimsatt has a robust notion of methodological reduction, he also sets the bar low for a system to qualify as emergent. He says, "*Aggregativity*, a claim that 'the whole is nothing more than the sum of its parts' is the proper opposite to emergence" (2006, 448). For there to be a complete reduction of a whole to its parts, the whole must be an aggregate. Aggregative properties "are invariant over proper rearrangements, substitutions, and reaggregations, and their values scale appropriately under additions and subtractions to the system" (459). These conditions are rarely met in biology; any systemic complexity at all indicates that there is likely to be a whole with properties that are irreducible to components. This observation does not deter methodological reductionism, but does go towards showing how an eliminative version of interlevel reduction is misguided.

Another antireductionist strategy is to show how predicates attributable to the whole cannot be attributed to the parts. An inability to reduce the predicates of a higher-level description to the lower-level description indicates an irreducibility. This tack, advanced by Rom Harré, comes out of the philosophy of language conjoined with a way of understanding scientific explanation via different models (Harré, 2006; Grene, 22-29). In these terms, "The reductionist strategy is to insist that the rational course is to delete one of the two sets of predicates to achieve a

unified discourse" (502). Polanyi frames his argument in a way similar to Harré when he notes that, "questions in which we are interested arise in the context of experiences which do not consist in atomic configurations, and which may not be derivable from the conceptual framework of atomic configurations" (*KB*, 175). Harré and Polanyi affirm that the higher-level context of experience presents us with phenomena which are just as real as the lower and which cannot be reduced away.

Polanyi's claim for emergence and against reducibility is similar to and yet a bit stronger than both Wimsatt and Harré's routes. The sun, for example, is more than a simple aggregate and different predicates apply to it as a whole than to its parts, but it is not an irreducible, emergent entity for Polanyi. Polanyi says "Irreducibility must not be identified with the mere fact that the joining parts may produce features which are not observed in the separate parts. The sun is a sphere and its parts are not spheres, nor does the law of gravitation speak of spheres; but the mutual gravitational interaction causes the parts of the sun to form a sphere" (*KB*, 230-1).

Polanyi reserves irreducibility for living systems and for certain artifacts. There is, he says, "*a discontinuity between machines and living things on the one hand and inanimate nature on the other hand*" (*KB*, 230). What makes us, and machines, special for Polanyi, is that we are dual control systems. And seeing how our body is layered with dual controls, gives us good *prima facie* support for the idea that the relation between the mind and the body is also one of dual control.

A basic feature of dual control is that it gives us two levels of analysis and, although the matter may be shared, the higher level will need its own set of laws and is not legitimately reduced to the lower level and its laws. Hence Polanyi requires that biology remain a field of study independent from physics.

Methodological Reductive Explanation in Biology

The reductionist vs. non-reductionist debate can get caricatured so that from one side or the other the opponent is really just a paper tiger. As Polanyi advanced his philosophy, the main issue of the debate became more clearly defined. In a book honoring Polanyi in 1971, Marjorie Grene summarized the state of affairs with regard to the biological sciences:

Both sides nowadays agree that living systems are made of the same kind of matter as non-living, and obey physical laws; the question is only: do those laws state the sufficient as well as the necessary conditions essential to the description and explanation of biological phenomena? (16)¹²

The problem is not in the doing of science, but in understanding what that doing does and does not entail. Tacit metaphysical assumptions at work in this debate are clarified through a rough distinction between epistemological reduction (including theory reduction), ontological reduction and methodological reduction.¹³

Methodological reductions are heuristic tools; analyses and reductive models are used to aid in the discovery of causal connections. Although methodological reduction makes use of theories, it makes no strong claim about either an epistemological or ontological reduction.

An epistemological reduction is explanatory; it takes hold if, in order for us to understand an entity and its relations, we must look at it in terms of an analysis to its component parts and their laws, and if this provides a complete explanation. Since we understand via theories, showing that a theory in one domain of science is translatable into a different theory, might prompt one to believe there is an ontological reduction as well.

The "dangerous" reduction for higher-order entities such as ourselves is an ontological one, but only if it is accompanied by the notion that a reduction to parts effaces the reality of the reduced entity, and makes its purported effects merely apparent. This reduction seems assured if the laws of physics "state the sufficient as well as the necessary conditions essential to the description and explanation of biological phenomena."

The positivists aimed for an epistemological reduction that was neat and clean and could be fully specified—and even when that was not "yet" possible on the side of our knowing, there was confident optimism that a reduction was indeed there to be found on the side of being. The confidence in ontological reduction was supported by apparent success in the way a theory about higher-level phenomena might be reduced or translated into a theory about lower-level phenomena. Since the lowest universal level was comprised of the phenomena studied by physics, a unity of science demanded that all branches of science would find complete explanations in terms of physics and its laws.

Providing an epistemic reductions in biology turns out to be the most difficult case to support (Wimsatt, 457; Horst, 50), but even when we are at a loss here, faith in an ontological reduction can often persist.¹⁴ It may be odd that successes in epistemological reducibility encourage ontological reducibility, but that failure in epistemological reducibility does not encourage ontological irreducibility. One reason, other than our humility, is that the success of mechanistic causal explanations is thought to be working towards an epistemic and ontological reduction. Hence the progress of science comes to look like the compiling of more and more evidence for an eliminative reduction. The success at discovering mechanistic causes—in the light of Descartes' excesses and a *reductive* conception of the body as a machine—shift the burden of proof to the ontological *anti*-reductionists. But if, as Polanyi shows with his conception of dual control, mechanistic explanations do not entail an ontological reduction, the burden of proof should rightly switch back the other way. As Wimsatt now emphasizes:

A reductive mechanistic explanation should not deny the causal efficacy of or eliminate higher level entities or properties, including their powers to affect lower level phenomena. My account shares this feature with classical images of dualism, but is at odds with philosophical accounts of identity or epiphenomenal theories that locate all of the causal movers at the lower level (Wimsatt, 2006, 451, ft#8).

Understanding Polanyi shows one reason why Wimsatt is right. Polanyi's conception of emergent being, in which a higher level can control the boundary conditions left open at a lower level, rules out an ontological reduction. Also, Polanyi's conception of tacit knowledge, and the hierarchies formed by levels of meaning, rule out any complete epistemological reduction from an emergent level to a subsidiary level, since knowing and being here are intertwined (*KB*, 218). Here irreducibility of meaning—epistemological irreducibility—aligns with the irreducibility of being. What's left is a methodological reduction in the service of investigating mechanistic causes and developing better theories for how each level works and how it interacts with levels below and above.

Why the Eliminative Reduction of Mind to Brain is Generally Ill-Conceived

Polanyi and Grene argue that reductive analysis is a wonderful heuristic, but articulating causal mechanisms does not entail an eliminative reduction. *Why did we think that it did?* We receive similar answers in slightly different language from Grene, Wimsatt and Harré.

Grene, following Polanyi, blames the reductivist program on the positivists and their Cartesian assumptions. Positivist theories of explanation tended to reduce everything to one flat phenomenal level in order to unify and ground knowledge. But this reduction of one phenomenon to another is not the same task as searching for causes in science; belief in a reduction proceeds more from Descartes' axiomatic and reductive ideal than from actual scientific practice.¹⁵ "Indeed, it is strange that the orthodox theory of explanation, which is phenomenalistic in intent, supposes itself also to be causal. To predict one darned thing after another is not in any sense to say why one follows the other" (Grene, 27). Instead, says Grene, "Admit, on the contrary, that scientists are trying, not to tie phenomena together into convenient bundles, but to look for the hidden mechanisms that produce them, and you are rid of... one of the prime motives for demanding universal reduction" (28).

Grene uses Polanyi's conception of dual control (31) to show how mechanistic reduction does not entail what Wimsatt calls "nothing but-ism" (446). She says that for higher-order entities to be "governed by" the laws of physics means that they must "obey" these laws. In this respect the laws of physics are universal. But being governed by the laws does not mean that they are fully explained by these laws with no remainder. In the light of Polanyi's conception of dual control, Grene can say that "The success of analytic biology and the power of the unity of science ideal" can encourage reductionism as a "methodological maxim" (Grene 21), but they do not contradict the emergence of higher-level entities with their own ordering principles. And while "[r]eductivist or analytic techniques... have been and will be of great heuristic value; the same is true... of systemic or relational techniques as well. Only an outworn and overly abstract theory of theories compels us wholly to exclude the second in favor of the first" (Grene, 32-33).

Wimsatt also shows how the progress of science can mistakenly encourage a belief that we are progressing toward an eliminative reduction. He separates the honest pursuits of reductionism into "successional reductions," where one

theory supplants another, and "interlevel reductions," which, he argues, involves an articulation of mechanism, but do not imply an ontological reduction (2006).

According to Wimsatt, the notion of eliminative reduction legitimately takes hold in the succession of one theory by another. Here the new and better theory may fail to capture entities posited by the old. Since the two theories are dealing with phenomena at the same level, this may indeed result in the disappearance of entities—but not, of course, the phenomena that the theory needs to explain. In contrast, with interlevel reduction we are primarily searching for mechanisms; we are seeking explanations for a system in terms of its components. This search accounts for the bulk of scientific progress, but whether the explanation is successful or not, it is also *not* eliminative. That which needs explaining remains. Thus Wimsatt says, "Interlevel reductive explanation, successful or not, is never eliminative. Eliminative (interlevel) reduction is a mythic invention reflecting older aims of ontological economy since abandoned" (457).

Wimsatt argues that conflating successional together with interlevel reduction encourages the mistaken notion that higher-level entities are reducible to lower-level components (457). A reductionism that would eliminate the higher-level phenomena and leave only the lower-level as that which contains *the* ontologically real things is the sort Wimsatt has in mind when he says, "eliminativism is generally ill-conceived" (445).

It is, however, conceivable that correspondences between a lower-level theory and a higher might move towards eliminating the higher-level entities and these might then reduce. Correspondences can be postulated by identity claims, e.g., that this state of consciousness is *the same as* that configuration of neurons firing in this sequence. According to Wimsatt, fruitful research can ensue from interlevel correspondence claims, but eliminations are rare. Typically, according to Wimsatt, "as we proceed we are given not correspondences, but pieces of mechanisms" (454) and the correspondences we can construct turn out to be "richly context-dependent" (455). "Paradoxically, reductionists frequently must expand the boundaries of what was originally taken as the system to include structured aspects of its environment in order to complete their task—becoming, in a way, more holistic as they succeed" (461; see also 450).

Eliminative reductionists might concede that interlevel reductions are not ontological reductions, but still argue that mental phenomena are *not at* a higher level that has gained ontological independence. They then predict that theories we have about mind and its workings will then be succeeded by better theories about brains as neuroscience progresses. The elimination of mind would then occur as an intralevel successional reduction, rather than an interlevel causal reduction. This sort of an argument only has a chance of succeeding if the phenomena of mental experience are reducible to the experience of brains, and so it must meet the same rigorous parameters of an interlevel reduction: it requires the identification of mental experience with something like brain states, and with nothing left over requiring further explanation.

Polanyi's structure of tacit knowing shows why this route to reduction will not work. Even if mechanistic reduction could fully account for all the phenomena of body and brain, the meanings we encounter at the level of mental experience cannot be reduced. Rom Harré and John Searle provide similar arguments to claim that there are experiences, and predicates for them, that can never be reduced to brain.

Harré describes Wilder Penfield's experiments to make the same point Polanyi does about the *from-to* structure of intentional consciousness. When a section of the brain is being excited by an electric probe, the patient tells what he or she is experiencing. The neurophysiologist's results here only mean something in terms of the patient's experience, so the mind's experience and its meanings cannot be reduced to the physical brain; descriptions in mental terms will require predicates that cannot be obtained by examination of the brain as a physical system. In Polanyi's language, what the patient observes by *looking from* the subsidiary structure is different from what the neurophysiologist can observe by *looking at* it. Harré exclaims that how eliminating higher predicates could be reconciled with this methodology "remains a mystery!" (Harré, 502)¹⁶

John Searle, with his conception of intentionality, says something similar to Polanyi and Harré. Although the mental experiences we have depend upon the brain, they are not reducible to it. He, too, separates the mechanistic explanation from the higher-level phenomena. We can provide a causal account, says Searle, "But where, then, is the visual experience in this account? It is right there in the brain where these processes have been going on" (267). The higher-level phenomena is "realized in" the lower-level bodily activities, for Searle (265), just as the mind is the meaning of the body for Polanyi (*KB*, 238). Though based in the same matter, the higher level is independent and can in turn exercise a causal influence. Visual experience is "caused by the underlying microphenomena, and in turn cause further phenomena" (Searle, 267).

Patricia Churchland attacks Searle's resistance against a reduction of conscious states to brain states, while making it seem like the method and progress of science is on her side.

Traditionally, it has been opined that the best the reductionist can hope for are correlations between subjective states and brain states, and although correlations can be evidence for causality they are not evidence for identity. Searle has tried to bolster that objection by saying that whereas a/b identifications elsewhere in science reveal the reality behind the appearance, in the case of awareness, the reality and the appearance are inseparable—there is no reality to awareness except what is present in awareness. There is, therefore, no reduction to be had (1993, 30).

She claims that Searle "fails to appreciate why scientists opt for identifications when they do. Depending on the data, cross-level identifications to the effect that a is b may be less troublesome and more comprehensible scientifically than supposing thing a causes separate thing b" (30). She gives several examples of identifications: "Science as we know it says electrical current in a wire is not caused by moving electrons; it is moving electrons... Temperature is not caused by mean molecular kinetic energy; it is mean molecular kinetic energy." (30) The implication she casts is that mind is not caused by the brain's functioning; it is the brain's functioning.

What Churchland is doing, however, is providing mechanistic explanations for phenomena we experience at a higher level. Just as "the red surface of an apple" is explained by "a matrix of molecules reflecting photons at certain critical wavelengths" or "the sound of a flute" is explained by "a sinusoidal compression wave train in the atmosphere" (1988). The theory is explaining electrical current, temperature, color, or sound, and is not replacing one theory with another. She is not eliminating the phenomena nor how it can be described in higher-level contexts; she is not even eliminating our typical language for it, but the reduction is a linguistic one: She is turning the causal explanation into definition, and then, as Harré might say, she is moving from a discourse strategy to an ontological conclusion" (Harré, 502).

Grene might say here that Churchland is presenting a classic case of mistaking a mechanistic explanation for a phenomenal reduction. Wimsatt would say Churchland is illicitly taking interlevel reductions as the elimination of higher-level phenomena. Whereas the above examples seem fairly innocuous, the divide she is crossing becomes clear in her Betty Crocker example. Here she uses the succession of one theory by another to illicitly enlist the mechanical explanation into a reductionist agenda.

Churchland says that something goes wrong when one attempts to "generate explanations that maintain the nonidentity and causal dependency of ...heat and molecular motion. Unacquainted with the relevant convergent data and explanatory successes, one may suppose this is not so difficult. Enter Betty Crocker...[Betty] says that when you turn the oven on, the microwaves excite the water molecules in the food, causing them to move faster and faster..." So far so good, Churchland comments, but instead of stopping there "[Betty] goes on to explain that because the molecules move faster, they bump into each other more often, which increases the friction between molecules, and, as we all know, friction causes heat. *Betty Crocker still thinks heat is something other than molecular KE; something caused by but actually independent of molecular motion*" (her italics, 30).

But what Betty Crocker does is give a mistaken explanation of how a microwave works. Her theory was succeeded. The phenomenal experience Betty alludes to, however, is *not* reduced in the process. When we rub our hands together, we still feel heat. Why do we feel heat? Enter the causal explanation.

The mistake of thinking that upper-level phenomena will be reduced or eliminated is exacerbated because the progress of science is mistakenly conceived as providing the support for a metaphysical assumption. The Churchlands perform what Wittgenstein would call a conjurer's trick (*Philosophical Investigations*, #308). They make it look like you are challenging science's method and success by challenging their picture of an ontological reduction to physical particles.¹⁷ But as Wimsatt says, "Robust (multi-detectable) higher-level entities, relations, and regularities...don't disappear wholesale in lower-level scientific revolutions. Transmute, add (or occasionally subtract) dimensions, or turn up in different ways—yes, but disappear—no. Eliminativism rests on exaggerated or incorrectly described accounts of unrepresentative cases" (457).

Emergentism and articulatory reduction can go hand in hand in studying the mind and brain without the danger that mental experience will reduce to brain states. But, giving the Churchlands their due, both Harré and Wimsatt acknowledge that there is some room for elimination. Harré allows that sometimes the boundary between two separate languages grows to become "permeable" and an identification of predicates can take place (500). But he also warns that some predicates resist reduction. For example, "The criteria for identifying persons are not commensurate with anything in the natural sciences" (508). Although Wimsatt, too, believes that persons will not be eliminated by the advance of neuroscience, he says that they may be "shaved or thinned" a bit by a modest eliminativism (460, footnote #19).

Rethinking the Machine Metaphor

The example of a machine, understood in terms of dual control, aids in understanding why emergent entities/systems cannot be reduced to basic parts and their laws. And it shows how higher principles may be operative and how degrees of freedom can be exercised in the context of underlying material necessities. The machine thus functions well to show how mechanical causal explanation does not reduce emergent entities.

Looking at a machine can also illustrate how we see *from* the parts to an emergent meaning. We dwell in the clues that the parts provide, along with clues from the wider context, in order to understand the machine as a whole and what it is supposed to do. Spread its parts across the floor and the machine is no longer visible.

The machine example seems to have limits, however, that might invite again the Cartesian conception of a completely separate spirit, i.e., Churchland's "spooky stuff". After Descartes, Leibniz also used the idea of a machine to show how the perceiving mind must differ from the material mechanism. In *Monadology*, Leibniz says,

And supposing that there were a machine so constructed as to think, feel, and have perceptions, and yet preserving the same proportions, so that we might enter it as into a mill. And this granted, we should only find on visiting it, pieces which push against another, but never anything by which to explain perception. This must be sought for, therefore, in the simple substance and not in the composite or in the machine.¹⁸

By *looking at* the human body, Leibniz could not conceive how we could *look from* it to experience objects focally. Rather than see visual experience as something that emerges in the complexity of a system, the only possibility he could imagine was that a different substance was at work. Thinking about the machine might then obscure the two different types of attention we might have as conscious, perceiving organisms, but widening the class of machines we consider might correct for this. Instead of thinking of a mill or a steam engine, we can think of machines that more conspicuously extend our abilities. For instance, when we use a machine like a bicycle, we can *feel* the road. When we use a confocal microscope and computer software, we can see mitochondria in a cell in three dimensions.

Enlarging these machines and looking *at* them, does not give us the feeling of the road or the image of mitochondria, but looking *through* these machines and their parts—dwelling in them—does.

The mind, as an active center and higher-order entity, has experiences that cannot be reduced to the brain, nor is it strictly localized and dependent on the brain's components for its clues. Another mistake Descartes promulgated was the idea that the soul or mind—though without extension—was localized to a point in the brain where its simple substance interacted with the body, perhaps at the pineal gland. The belief that mind will reduce to a point in the brain, or even to the brain itself, ignores the full panoply of subsidiary clues that go into conscious experience.

Polanyi's depiction of tacit knowing shows how the mind extends beyond the brain. Consciousness reaches out through tools and the body into the world. What is important in our experience of the probe, for instance, is not just the firing of neurons, nor even the muscles in the body or the receptors in the skin. Consciousness moves beyond the body to the tip of the stick to bring a focal experience of a darkened room. The body and the technology that extends its reach become part of the tacit background that supports consciousness and the functioning of the mind; we dwell in the clues of the body, but we dwell in clues out in the world as well.

The current notion of mind extension popularized by Andy Clark in *Being There* and *Supersizing the Mind*, can be understood as an expansion of Polanyi's notion of indwelling.¹⁹ Clark says,

There is, after all, a quite general difficulty in drawing a firm line between user and tool...Some birds swallow small stones to aid digestion—are the stones tools, or, once ingested, simply part of the bird?...Public language and the props of text and symbolic notation are, I suggest, not unlike stones swallowed by birds... Much of what we commonly identify as our mental capacities may likewise, I suspect, turn out to be properties of the wider, environmentally extended systems of which human brains are just one (important) part" (1997, 214-5).

The extension of mind through machines helps to show how matter is the medium of mind. But at the same time, it should caution against the reduction of mind to matter. The parts of the mind include social and cultural meanings that can't properly be said to belong to the brain and its physiology.²⁰

Greene says, "To define living systems... as machines capable of improving their own programs may sound to 'organismic' biologists like one more reductive slogan. Yet it says in effect: look to engineering—to blueprints and operational principles—not to chemistry and physics—for the sources of your theoretical models in biology" (Greene, 31). Following Polanyi's lead, the machine metaphor can be refurbished to warn us away from Cartesian errors and to symbolize emergentist goals. The metaphor of an organism is certainly better than that of a machine at illuminating holistic systems, but it is unavailable as a metaphor when we are talking about organisms themselves.²¹ Identifying dual controls in machines is a step in the right direction towards a more holistic thinking that respects the integrity and freedom of emergent entities. Metaphysical anti-reductionists should embrace the metaphor of the machine, even if, at first, it seems impersonal and cold to the touch.

A Quiet Revolution: The Rise of the Machine

Polanyi's understanding of tacit knowing and emergent being corrects Cartesian excesses. Analysis is a powerful tool for gaining knowledge. Descartes was indeed right to focus on mechanisms and mathematics, but, after Polanyi's insights, we can see how his way of thinking could lead to err, and how one mistake builds on another. Mistakes about knowing encouraged mistakes about being. The modern day scientism resulting from these mistakes encourage the conclusions that (1) all scientific knowledge is completely objective and value-free; (2) that what *really* exists are the basic atomic materials; (3) that human meanings are artificial constructs in a material, objective, value-free universe—and so meanings are merely in our minds; and (4) since our minds are also constructs from this same basic material, the human mind itself, as one experiences it, is an illusion.

Polanyi outlines a general structure by which we can best conceive of our knowledge and the things we know. He not only shows us why we were led into a false understanding of dualism, he provides a general framework for how we might correct it, and not fall prey to its dilemma. The reductionist drive gave rise to a sharp substance dualism, which made us believe we needed to choose between matter and mind. Polanyi's new understanding of dualism, via subsidiary vs. focal attention and dual control, preserves the reality of human minds and indicates how degrees of freedom are compatible with material causation. Understanding the machine in a new way becomes the key to re-conceptualizing our understanding of ourselves and the world around us.

Over sixty years ago, Polanyi began a quiet revolution against the excesses of analytic philosophy and its idealization of reductive and fully explicit explanations. Polanyi's views at first seemed radical. But in the wake of extreme backlashes—such as postmodern irrationalism, on one side, and eliminative materialism, on the other—Polanyi's solution begins to re-appear as moderate and proper synthesis. Current movements in understanding the role of reduction in biology and the nature of the mind can utilize his structure and benefit from his insights.

ENDNOTES

¹ This is why the images of substances have "more objective reality...than those [images] which represent to me only modes or accidents" (Descartes, 119).

² A "level" approach simplifies the more complex relation between systems; it is often difficult to determine the higher from the subsidiary. This recognized by Grene (17) and Wimsatt (461), and was also likely recognized by Polanyi.

³ References to Polanyi's collection of essays, *Knowing and Being*, will be cited "KB".

⁴ Polanyi continues: "Mathematical reasoning about experience must include...non-mathematical relating of mathematics to such experience and the eventual, also non-mathematical, understanding of experience elucidated by mathematical theory" (KB, 179).

⁵ See Dewey, *Experience and Nature* (Chicago: Open Court, 1929), 33.

⁶ According to Steven Horst, Physics became reductionistic in the 19th century due to its "math envy" (Horst, 68), and according to Grene, biology was becoming reductionistic in the 20th century due to its "physics envy". But ironically, as Woese points out, just as biology was endeavoring to become more reductionist, physics was becoming less reductionist (Woese, 174).

⁷ In the extreme cases of a scientific revolution this process can be seen most clearly. Gathering facts in a field of knowledge can outrun our theoretical understanding of how they go together. A paradigm is a joint comprehension of meaning that is seen through to the facts it organizes. This tacit role can account for the indefinability of "paradigm" with which Kuhn struggles.

⁸ This same criticism, as we'll see, can be applied to Patricia Churchland's (1994) way of identifying a higher-level phenomena with its lower-level causes.

⁹ Grene says that Polanyi's argument for the irreducibility of DNA "appears incontrovertible" (18).

¹⁰ See Lowney, "Seeing, Saying and *Being* the Gestalt", *Appraisal* 7:1, (2008), 21-38.

¹¹ Since we also learn via subception, i.e., without awareness of the subsidiary clues we are mastering, we might never be come aware of the clues involved in our learning (*KB*, 143).

¹² In the mid 60s and early 70s an interdisciplinary group met to oppose the scientism they saw as a dominant strain in our culture's ideal of knowledge. They called themselves the "Study Group on the Unity of Knowledge". Participants included Marjorie Grene, Alasdair MacIntyre, Charles Taylor, Hubert Dreyfus, Noam Chomsky, Ilya Prigogine, Hilary Putnam, Richard Rorty, Jean Piaget, H. Paul Grice, John McCarthy, John Searle, Rom Harré, Jerry Fodor, Robert Cohen, Abner Shimony and others. Not that all these people agree with each other, or with Polanyi, but Polanyi was a significant influence. In 1971 the Study Group produced a volume of articles that was presented to Polanyi in honor of his 80th birthday. This volume is titled *Interpretations of Life and Mind: Essays around the Problem of Reduction*. An earlier volume put forward by the group, *Anatomy of Knowledge* (ed., M. Grene, Amherst: University of MA Press, 1969), included Polanyi's "The Structure of Consciousness".

¹³ This distinction is sometimes formulated as dividing "fundamentalist reductionism" and "empirical reductionism", the fundamentalist is metaphysically motivated, while the empirical reduction is methodological (Woese, 174).

¹⁴ Since Kant, it is common to hold that there might be no way to achieve an epistemic reduction, but still to maintain an ontological reduction. Kant argued in the *Critique of Judgment* that, due to the limitations of our reason, we need to understand organisms in terms of purposes, but that nature was built up deterministically and the laws of physics governed all phenomena. Teleological principles were merely regulative, but material causal principles governed time and space and were determinant.

¹⁵ Steven Horst also notes how the 20th century positivists are similar to the Early Modernists in the 17th century. They shared a in math envy and advocated the reduction of science to one theory with basic universal axioms (Horst, 55, 68).

¹⁶ Harré goes on to use Bohr's complementarity to show how two different affordances can be identified with the same event.

¹⁷ Patricia Churchland also claims that her reductionist physicalist view is an empirical hypothesis, and paints the anti-reductionist views as *a priori* (1994, 23, 27). This obfuscates the metaphysical question by having us believe that science will one day provide us with an answer—but what will count as an answer is already established by her physicalist picture.

¹⁸ G.W. Leibniz, *Monadology* paragraph 17, quoted in Searle, 267-268.

¹⁹ As Paul Lewis says in his review of *Supersizing the Mind*, "the book can be read as an extended commentary on and extension of many of Michael Polanyi's ideas" (*Tradition and Discovery*, 36:2 [2009-10] 86).

²⁰ See especially Rom Harré, 2006, on this social dimension of mind and the linguistic context for determining which properties are determinable in what domain.

²¹ Overton and Horowitz describe some deficiencies in how we typically conceive of machines: "a machine metaphor generates metatheoretical assumptions or categories that represent the domain under examination as inherently reactive, isolated, linear, random, and initially uniform. This frame then serves as the context within which specific theories are generated. For example, Freud's (1915)... On the other hand, an organic metaphor generates assumptions asserting that the domain is best represented as inherently active, relational, dialectic, directional, and that it possesses some initial organization. British object relations theorists, including Fairbairn, Bowlby, and Winnicott, for example, all rejected Freud's reactive constancy principle and instead constructed theories based on the principle that organisms are inherently active" (Overton, W. and Horowitz, H., "Developmental Psychopathology: Integrations and Differentiations" in Chicchetti and Toth, eds., *Models and Integrations*, Rochester: University of Rochester Press, 1991, 3-4).

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