

SOME COMMENTS ON THE PROBLEM OF REDUCTIONISM IN CONTEMPORARY PHYSICAL SCIENCE

by Frank E. Budenholzer

Abstract. Is reductionism simply a methodology that has allowed science to progress to its current state (methodological reductionism), or does this methodology indicate something more, that the material universe is determined in full by its smallest components (ontological or causal reductionism)? Such questions lie at the heart of much of the contemporary religion-science dialogue. In this essay I suggest that the position articulated by philosopher-theologian Bernard Lonergan is particularly suitable for dealing with these questions. For Lonergan, the criterion of the real is simply its verified intelligibility and not its imaginability. Each of the various levels of reality, as studied in sciences such as physics, chemistry, biology, and sensitive and rational psychology, consists of an intelligible integration of what on the lower level would be simply random occurrences. The things studied by the various sciences (atoms, molecules, cellular organisms, animals, human persons, and so on) are intelligible unities, and no one level is somehow more real than any other. I argue that such a scheme, while seeming somewhat counterintuitive, is best able to deal with the multilayered reality of the contemporary physical and life sciences and provide an opening to the richness of the social sciences and the achievements of human culture.

Keywords: cognitional analysis; critical realism; descriptive and explanatory science; intelligibility; Bernard Lonergan; reductionism.

In current work on the relationship of religion and science, arguments over “reductionism” in science have become more and more common. Is reductionism simply a methodology that has allowed science to progress to

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its current state (methodological reductionism), or does this methodology indicate something more, that the material universe is determined in full by its smallest components (ontological or causal reductionism)? (Agazzi 1991)

Often the argument is accompanied with strong emotional overtones. Edward O. Wilson (1998) and Peter Atkins (1995, 127; quoted in Barbour 2000, 155) argue that contemporary science demands an ontological reductionism. It seems so obvious. Matter is composed of tiny particles that, either as individual particles or ensembles, obey the basic laws of physics. Hence, biology is just chemistry, chemistry is just atomic physics, atomic physics is just elementary particles physics, and so on. Reductionistic physics is all there is.

To the antireductionists, reductionism seems all wrong. While the intellectual allure of an ontological reductionism is admitted, it seems to deny too much. First, it seems quite out of tune with how science is actually performed. Methodological reductionism has had its successes—the explanation of the periodicity of the chemical elements using basic quantum mechanics and the clear successes of molecular biology. But sciences on all the various levels seem to have their own integrity and their own laws. Ontological reductionism is at best an hypothesis that still needs to be proved.

But perhaps more important, ontological reductionism seems to deny our own experience of ourselves as persons. Is human consciousness simply an epiphenomenon (Dennett 1991)? What happens to our basic beliefs and values if ontological reductionism holds sway? What of human freedom and the human person as knowing and loving? Arguments about the nature of the human person and consciousness have traditionally centered on the concept of the human soul. And while understanding the human soul involves much more than the question of ontological and epistemological reductionism, it would seem that the successful resolution of the problems related to reductionism is basic to any discussion of the soul.

Those who hold to traditional concepts of the soul have argued for an element of the human person that transcends the material. Some would argue that present understandings of neuroscience are at variance with this tradition. Be that as it may, it can be argued that one can be a materialist without necessarily accepting ontological reductionism. This would seem to be the contention of Nancey Murphy in her recent work, where she uses the concept of “supervenience” to argue the possibility of a nonreductive physicalism (Brown, Murphy, and Malony 1998, 130).

This is simply a rough sketch of the current debate. The reader is referred to the original sources for the nuances of the arguments. However, I suggest that in much of the debate, certain basic philosophical issues have not been addressed. What is the conception of reality upon which the various arguments are based? Some might argue that this is to allow meta-

physics to intrude on what should be a scientific issue. But if the history of modern philosophy, beginning already with David Hume, has taught us anything it is that any understanding of reality has its own nonscientific presuppositions. If we want to talk about reductionism, the soul, or similar issues, we cannot avoid making metaphysical assertions. A similar situation has evolved in modern quantum mechanics and relativistic physics. It is impossible to make foundational statements about the nature of physical theory without making statements about the basic nature of reality, that is, without making metaphysical assertions.

In what follows I suggest that an intellectualist position, as best exemplified in the thought of the Canadian philosopher-theologian Bernard Lonergan (Lonergan [1957] 1992; Flanagan 1997), can supply the foundations for a nonreductive critical realism that is true to the exigencies of contemporary science. It should be noted that this essay is limited to several key foundational questions that I believe are critical to making progress in dealing with the problem of reductionism. A full treatment that includes a philosophy of emergence and development would require a much longer article and is not attempted here.

DESCRIPTIVE AND EXPLANATORY SCIENCE

We must first make a distinction in our description of human knowing, what Lonergan refers to as “descriptive” and “explanatory” science.¹ Descriptive science has to do with things in relation to us. I experience the blue sky or the refreshing water of an early morning swim. My understanding of these experiences always retains my own subjectivity as one of the poles of my knowing. While these experiences are from ordinary living, descriptive science is also a part of all scientific knowing. This would be true of my understanding of the lines on a computer monitor representing a molecular spectrum or the understanding of an anatomist as he or she completes a dissection.

In explanatory science, we go one step further. The subjectivity of the observer is removed, and there is sought an understanding of things in relationship to each other. Thus, in descriptive knowing, I understand that certain sounds will alert me to the presence of various objects in my field of experience. A helicopter is flying overhead, traffic is coursing in the streets below. If verified, these understandings represent true knowledge of my surroundings. However, this knowledge is not scientific knowing, for the knowledge is still related directly to me as subject. Scientific knowledge, on the other hand, is concerned with things as related to things. Scientific understanding involves the relationship between oscillating mechanical components and the resulting oscillations of molecules that are then propagated through the atmosphere as sound waves. If no humans were here, would there be sound as understood descriptively? No. There

would be no one to hear it, and there would be no subjectivity with which to relate. Would there be waves propagated through the air? Yes. Scientific understanding is of things related to things and is valid irrespective of my being present.

WHAT IS REALLY REAL?

What, then, is the real? Lonergan would argue, and I think correctly, that the real is simply verified intelligibility.² As creatures in a material world, our knowing begins with experience. But experience calls forth understanding. If that understanding is verified, not only by myself but in the long history of science, that verified intelligibility is true and real. Heat is the random kinetic energy of particles in motion. An earlier theory had defined heat as analogous to a fluid that flowed between hot and cold. That theory was found wanting and has been replaced by the current understanding. If this theory of heat continues to be substantiated as science continues to develop, then I suggest that it is true, and heat really is the random kinetic energy of particles in motion. The real is confirmed intelligibility.³

At first glance, to say that the real is verified intelligibility seems quite commonplace. And in one sense it is. Most scientists would agree that the understanding or theory that best explains the phenomenon under consideration is the best approximation of the truth. They also realize that further developments may force a rethinking of current theories—hence, the caveat that verified intelligibility must await the judgment of further scientific history before its reality can be assured. But at the same time there is confidence that science is about knowing the real and that the best scientific explanation is that which provides the best explanation. Lonergan, along with other philosophers, describes this epistemological position as “critical realism.” The goal of science is to know the real, and there is every reason to believe that current scientific understandings are, if not true, at least moving in the right direction. At the same time, there is a tentativeness about scientific knowing, hence the adjective *critical*.⁴

What separates Lonergan’s thought from that of many others is his suggestion that, with the exception of what he refers to as the empirical residue, the givenness of particular places, times, and numbers, the criterion of the real is simply its intelligibility.⁵ Lonergan would argue that the root of much of the philosophical confusion of modern and contemporary thought lies in an added criterion, its imaginability. We as humans are animals. And animal knowing consists in manipulating imaginable constructs. Human knowing is able to understand the real as the true. Thus, the theory of quantum mechanics, at least as far as contemporary science can tell us, describes the real nature of atoms and molecules and their interaction with electromagnetic waves. While there are problems, the

theory in itself is quite consistent. The so-called wave-particle problem appears only when we try to imagine what the theory is telling us. Because our knowing begins with animal knowing, pictures are important. But ultimately the real is verified intelligibility and not constrained by our ability to imagine it.

Most would be comfortable with such an understanding of the real when speaking of elementary particle physics. The world of quantum electrodynamics seems to have left the world of imagination behind. But what about the more mundane areas of science, such as physiology, evolutionary biology, or geology? We of course experience ecosystems, fruit flies, and other people. Sciences such as anatomy begin as a descriptive science, ordering the various experienced and imagined parts of the organism. But the reality of the organism does not lie in these parts, which are experienced. Ultimately, the organism is a unity-whole with all the myriad functions such as metabolism, reproduction, and sensation that are described by modern biology. The reality of the organism is, of course, completely consistent with the descriptive science that understands my relationship to the organism. However, to limit the reality of the organism to its imaginable features would seem to leave out most of modern biology. This unit that we come to know, whether another person, an organism, a molecule, or an atom, is what Lonergan refers to as a “thing”—“a unity, identity whole” ([1957] 1992, 275). Lonergan contrasts “things” with “bodies.” Bodies are the objects of extroversion. Lonergan defines them as an “already, out there, now, real” ([1957] 1992, 276). As objects of extroversion, they are out there. As true objects of our senses, they are real. They are there now, because they are experienced in the present. Just as do other higher animals, we experience a world filled with “bodies.” However, as human knowers we realize that their reality transcends our being able to feel and imagine them. If our knowledge simply consists in knowing bodies, we live in a very truncated world, far from the fuller world revealed by contemporary science. The real is the true, nothing more and nothing less.

To describe the properties of things and events, Lonergan employs the technical term *conjugates*. “Experiential conjugates are correlatives whose meaning is expressed, at least in the last analysis, by appealing to the content of some human experience” ([1957] 1992, 102). Colors, tastes, and the feel of things are examples of experiential conjugates. “Pure (or explanatory) conjugates, on the other hand, are correlatives defined implicitly by empirically established correlations, functions, laws, theories, systems” ([1957] 1992, 103). The properties implicitly defined by the equations of physics are explanatory conjugates: mass, energy, spin, color, charm. Explanatory conjugates are equally to be found at the level of chemistry—valence, reactivity, molecular symmetry—or on the higher level of biological organisms—gene expression, metabolic pathways, evolutionary niche.

We have already encountered the notion of a “thing.” Lonergan defines a thing as “an intelligible, concrete unity differentiated by experiential and explanatory conjugates” ([1957] 1992, 280). Things exist on various levels and are the unities that are explained—subatomic particles, atoms, molecules, cellular organisms, sensitive organisms, human persons that can transcend themselves in knowing and loving. Science knows each level through the descriptive and explanatory conjugates correlative to the thing under study. The criterion of reality of both conjugates and things is simply their verified intelligibility.

Each level of reality has its own set of explanatory conjugates, which are the particular subject of the science of that level—physics, chemistry, biology, sensitive psychology, and so on. No set of conjugates or level of things is more real than any other. The real is verified intelligibility at whatever level one is operating. Having said that each level is equally real is not to deny the clearly verified conclusion of levels of reality. At each level the random conjugates of the lower level are unified in a higher integration. Chemistry systematizes what would be merely coincidental events on the atomic level, allowing the emergence of an autonomous science of chemistry. Biology is an autonomous science integrating what would be merely coincidental events on the level of chemistry. The integration of coincidental manifolds at a new level does not take away the autonomy of the lower levels. The reality of the biological organism includes the conjugates of chemistry and physics. Because of this, the most exciting areas of science will be the cross-disciplinary areas—molecular biology, chemical physics, and so on. Here science attempts to understand how those lower-level conjugates are systematized at the new level.⁶

What does all of this have to say about the problem of reductionism? If the real is conceived as imaginable, then we are ultimately talking not about emerging levels but about bigger and more complex assemblies of imaginable pieces. Each level is reduced to the next. Knowing is about neural processes, which is about cellular mechanics, which reduces to chemistry, which is really just about the physics of particles in motion (admittedly made a little fuzzy because of quantum mechanics). But where do we stop with the imaginable pieces? And what do we do with relativity theory? Space and time are not intuitively self-evident, as Kant would suggest, but are intelligently affirmed in the postulates of special relativity. Perhaps the best solution is what at first glimpse seems the most radical. The real is verified intelligibility. Whether at the level of subatomic physics or at the level of human intelligence the imaginable is only the first step in our knowing process. The imaginable supplies the images by which we can grasp the intelligible reality at whatever level we are dealing.

From the intellectualist perspective of Bernard Lonergan, we must affirm levels of reality. Each new level systematizes what are essentially random conjugates at the lower level. The whole of contemporary science

intelligently grasps and reasonably affirms these various levels. But no one level is more real than any other, for their reality is confirmed intelligibility.

Some have accused Lonergan of being an idealist. In one sense this is true, but in a more important sense it is not. It is true in that for Lonergan basic reality lies not in some set of primary qualities, which I have subsumed under the aegis of imaginability, but in the confirmed intelligibility of being. However, Lonergan is not an idealist in the sense that it is all in my head, all my ideas (1972, 238–39). Particular individual things exist. As animals we bump into them and experience them all the time. But if we want to know their being, we must do science, and the ultimate criterion of science is confirmed intelligibility.

I suggest that Lonergan's notion of each level integrating what would be random occurrences on the lower level provides a basis for the much-discussed concept of supervenience. "Descriptions and formulations formulated at a higher level (e.g., human consciousness) can be seen as supervening on lower level explanations, even though they presume the necessity of the operation of processes at a lower level" (Brown, Murphy, and Malony 1998, 222). If we retain an imaginable image of the various levels, supervenience can seem to be only a logical stratagem to avoid ontological or causal reductionism.

Lonergan's cognitional analysis and metaphysics also forces us to re-think our understanding of matter, spirit, and the human soul. In a commonsense sort of philosophy, matter is what can be felt or imagined—matter is the hard stuff of experience. However, modern physics has already left this concept of matter behind. If the real is the intelligible, then what is matter? Lonergan argues that matter is that which is intrinsically conditioned by the empirical residue ([1957] 1992, 540). Spiritual would then be being that is not so conditioned. The human person is then spiritual in his or her intellectual capacity, for our grasp of the intelligible is not limited to the understanding of this or that particular instance. This, of course, has tremendous implications for our understanding of the human person and of that slippery term, the human soul. But to consider this question is the subject of another article and not my primary concern here.

CONCLUSION

In the introduction to *Insight* Lonergan makes a rather puzzling statement. He writes, "that there are two quite different realisms, that there is an incoherent realism, half animal and half human, that poses as a halfway house between materialism and idealism and, on the other hand, there is an intelligent and reasonable realism between which and materialism the halfway house is idealism" (Lonergan [1957] 1992, 22). At the level of subatomic and atomic physics, scientists long ago abandoned imaginability as the criterion of the real. To reintroduce imaginability at some higher

level because it feels right would seem to only obfuscate matters. That there is a hierarchy of levels is amply verified by modern science. But to proceed from this to an imaginative construction where the really real is the smallest subunit of matter is to make an assumption that is not warranted by contemporary science. There is no privileged level of reality, somehow more real than others. Accepting this in no way denies the value of a methodological reductionism. To thoroughly understand the higher level, one must also understand the lower-level conjugates that have been systematized. But we would deny giving any level ontological priority. The only way to understand our human nature, sensitive psychology, biology, and chemistry is to do the required science at the appropriate level of integration as well as thoroughly understand the more basic levels that are integrated at the higher levels.

NOTES

1. This distinction is common to many philosophers. See, for example, Searle 1998, 116–17.

2. In jumping immediately to this conclusion, I am of course bypassing much of the argument from *Insight* (Lonergan [1957] 1992). Lonergan begins with a careful analysis of human knowing, particularly scientific knowing, to identify the stages of human cognition. The result is his well-known triple cord of knowing: experience, understanding, and judgment. Only then after arguing why this is, in fact, knowing does he move on to metaphysics. Our purpose here is to simply suggest why Lonergan's thought can make an important contribution to the discussion of reductionism in science.

3. It should be noted that "confirmed intelligibility" here implies an historical process. How does one know when a particular understanding has been confirmed? Lonergan argues that confirmation occurs when all relevant questions have been answered, not simply all the relevant questions that a particular investigator happens to think of. Because science employs generalizations that lead to new questions, empirical science, at least as we know it, is always tentative. However, recognizing the tentativeness of science does not deny the basic premise of the real as verified intelligibility.

4. In the sense used here, *critical* implies a realism that is distinguished from some sort of naive realism. This is basically the sense in which thinkers such as Ian Barbour (1997) and Arthur Peacocke (1993) use the term. However, in the case of Lonergan and other philosophers of the so-called school of transcendental Thomism it can mean a metaphysical realism that finds its justification in a Kant-like "turn to the subject" and a critical appropriation of one's rational self-consciousness. For a dissenting view that sheds considerable light on the use of the term in modern Thomistic thought see Gilson 1986, 149–70.

5. On the level of scientific knowing, the so-called empirical residue must simply be taken as a matter of fact. There is no inherent intelligibility—why this electron is not that electron or this rabbit is here rather than there (Lonergan [1957] 1992, 50–56). The empirical residue also grounds statistical science where actual frequencies diverge from ideal frequencies. However, when Lonergan considers the possibility of the Divine, ultimately even the empirical residue finds its intelligibility in God ([1957] 1992, 686; Budenholzer 1984).

6. My basic point is that an adequate approach to the problem of reductionism requires a rethinking of the very nature of the real and the abandonment of criteria of imaginability. However, this important step does not exempt either the scientist or the philosopher from dealing with the further question of understanding the emergence of higher levels of integration, whether in the development of the individual organism or the human person or in the evolutionary history of our cosmos. This would be the subject of a further article. See Lonergan [1957] 1992, 470–507.

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