How Science Works: Foundations, Method, and Teleology

PUTTING PRESUPPOSITIONS ON THE TABLE: WHY THE FOUNDATIONS MATTER

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Abstract. Over time scientists have developed an effective investigative process that includes the acceptance of particular basic presuppositions, methods, content, and theories. The deeply held presuppositions are the philosophical foundation of scientific thought and do much to define the field's worldview. These fundamental assumptions can be esoteric for many and can become a source of conflict when they are not commonly shared with other points of view. Such presuppositions affect the observations, the conclusions drawn, and the positions taken. Furthermore, in some cases presuppositions in science have undergone important shifts in meaning, causing an increasing dissonance. We argue that disputes in religion and science often are due to these very basic differences in philosophy that are held by members in the different communities. To better understand the nature of science and its differences with religious views, presuppositions rather than conclusions should be articulated and examined for validity and scope of application.

Keywords: assumptions; history of science; materialism; naturalism; nature of science; presuppositions; scientific worldview.

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The Beginnings of Modern Science

Many scientists and historians of science such as Alfred North Whitehead have made a strong case that the basic worldview of Western Christianity was an ideal environment for the beginnings of modern scientific progress. Whereas in other parts of the world discoveries certainly were made, the understanding of nature lacked sustained growth. Whitehead credits two factors as important in Europe: the habits of thought shared by the religious and scientific communities and a strong faith in the actual possibility of doing science (see Psalm 111:2; Philippians 4:8). This was the foundation necessary to support the growth of science (Whitehead 1928, 18–19). Both factors are presuppositionally grounded and linked to Christianity. Francis A. Schaefer scholar Nancy Pearcey points out that Christian religion and modern science were not at odds philosophically in the sixteenth, seventeenth, and most of the eighteenth centuries when modern science began to grow. This period exhibited a wholeness in worldview that crossed disciplines (Pearcey 2004, 24).

Attempting to reconstruct the framework of thought in these early days provides valuable insight into the nature of doing science. As in any time, all reasoning and investigation must begin with taking many ideas as granted. For scholarship to get anywhere, it needs to be done within a framework of thought, a paradigm. The paradigm includes a cloud of very basic assumptions called presuppositions: assumptions about previously accepted theories and facts, assumptions about acceptable methods of study, and judgments about the qualifications of individual investigators and their institutions. Harold K. Schilling at the University of Iowa has noted that any error in the assumptions or presuppositions with which the reasoning begins is a source of greater error than other factors in scientific method (1973, 3–9). Schilling also did an excellent job of listing presuppositions operating in science and also in religion in his earlier classic little book (1958). He is concerned with the ideas that are supposed before we suppose anything else. The following list draws from his lists, which separated the religious and scientific presuppositions. We have added some points based on the history of science. With some modifications, one can backtrack, at least to some extent, into the framework of thought in the previous centuries that did not separate the two areas of thought.

Presuppositions in the Earlier Worldview

At the birth of modern science with scientists such as Copernicus, Galileo, and Kepler, it was generally held that

1. You and I are real.
2. God is real and unchanging.
3. Nature is real.

4. God created the universe, and it was good (complete, perfect).
5. Humans were created (in the image of God) to communicate with God and therefore can come to understand and know God's thoughts.
6. The consistent style of the Designer allows the investigator to make analogies between the known and the unknown.
7 God is not nature; God created nature.
8. Nature is orderly and follows laws because God is orderly and unchanging. He has established laws in nature.
9. A given cause can only produce the same effect.
10. Natural laws are unchanging and are independent of time.
11. Nature is intrinsically beautiful (perfect) because the Creator designed it. The earth, however, suffers the results of original sin.
12. The simpler explanation is more likely to be true, because perfection in the Creation would use fewer means rather than more in its operation (Occam's razor).
13. Nature can be studied and understood. We are rational beings designed to find cause and meaning.
14. Understanding and appreciating the Creation is a form of worship.
15. To measure something is to know it.
16. Mathematics is the basis of understanding (God's perfect language).
17. The sources of knowledge, nature and scripture, should be studied directly. Authority should be questioned and tested.

We do not claim that this list is exhaustive. We do suggest that these assumptions would often have been part of the mindset of early sixteenth-century European scholars whether a particular individual was a Christian or not. They were held well into the eighteenth century, imbedded in the very woodwork of European scholarly endeavor.

JOHANNES KEPLER

Not many know that the Lutheran astronomer Johannes Kepler (1571–1630) spent much of his life trying to figure out how God had designed the solar system. He accepted the Copernican Sun-centered system on the basis of simplicity and beauty: the old epicycles in the Earth-centered system worked but were clumsy. Mars, in particular, was difficult to track.

Now Sun-centered, he was fascinated by a possible design in the spacing of the planets. Kepler wrote, "But if God allotted motions to the spheres to correspond with their distances [from the Sun], similarly He made the distances themselves correspond with something" ([1596] 1981, 63). So it was rational to Kepler, but odd to us, that the "something" used to space out the planets would be the revered "perfect solids" of mathematics.

There are five perfect solids in geometry where all of the sides are equivalent: the cube, the tetrahedron, the dodecahedron, the icosahedron, and the octahedron. Historically Greek mathematicians held these shapes in high regard, and Kepler seems to have been a neo-Platonist. He assigned one to each orbit complete with commentary on why God would use a particular one in each place. Kepler believed that he could uncover God's thinking behind the invisible framework for the solar system (Kozhamthadam 1994, 24).

Kepler's solution was to alternate six spheres with the five perfect solids by nesting one inside the other. Starting on the outside, he placed a sphere on the orbit of Saturn, and then he placed a cube centered on the Sun inside this sphere. Then he fit a second sphere inside the cube to represent the orbit of Jupiter. Next, a regular tetrahedron was drawn inside this sphere to locate the next sphere that inscribed the path of Mars. Inside this sphere he placed the regular dodecahedron to fix the sphere in which Earth traveled. The regular icosahedron established the distance between Earth and Venus and the regular octahedron the distance between Venus and Mercury. In the process he thickened the spheres to allow for the elliptical shapes of the orbits. Ironically, he is remembered today for this passing discovery of the elliptical orbit, not for his model of nested polyhedra. He would be surprised, for his model had successfully explained why exactly six planets existed and how their spacing was determined.

It was convincing until more planets were discovered after Kepler's death. Alas, only five convex regular perfect solids exist (as is proved in Euclid's *Elements*, Book 13). To extend Kepler's model was impossible. For Kepler it was a convincing fit for the data, and, while we may find his reasoning odd, it is easy to see why he believed that the observational evidence supported his theory.

This gives us insight into the powerful effects of presuppositions. Kepler's worldview included the presuppositions that God would use mathematical relationships and that the structure would be aesthetically pleasing. The application of the perfect solids to spacing of the planets was a very reasonable fit. It is interesting that Kepler connected a system that he understood, the perfect solids, by analogy to a system that he did not understand, the spacing and number of the planets. He trusted that God's basic style repeats itself. For him the cause of the spacing was found in the five perfect solids. Kepler stated, "The mathematical things are the causes of the physical because God from the beginning of time carried within Himself in simple and divine abstraction the mathematical objects as prototypes for the materially planned quantities" (quoted by Livio 2002, 147).

Interestingly, in his discovery of elliptical orbits Kepler also rejected an application of the perfection presupposition. It was commonly held that, while the earth might be suffering from the results of sin, the heavens ought to still reflect perfect Creation. Circles were regarded as perfect;

hence, the orbits of the planets ought to be circles. Kepler did not let this restrict him and continued to defend his ellipses. Gerald Holton examined this brave move and quoted a reply by Kepler to one of his objectors that the only difference is that "you use circles, I use bodily forces." Kepler went on to maintain that the circles, epicycles, and orbs exist only in thought and are not real. Holton concluded that Kepler was moving physical understandings into astronomy and that "real" meant matter and mechanical interactions (1988, 61). But let it be noted that Kepler was saying that there was more to science than objective interpretation of observational data. Subjective choices have to be made.

Kepler was operating with most of the assumptions mentioned in our list. When his perfect-solids model was disproved and other metaphysical explanations floundered, it gradually became clearer to the scientific community that "thinking God's thoughts after Him" was speculative. This tended to put presuppositions out in the open and call them into question. Presuppositions shift over time under such pressure.

Newton's Choice

To manage the difficulties of shifting paradigms and the constancy of God, Isaac Newton (1642–1727) set a major precedent by making an interesting choice: He used analogy to explain the behavior of light by using waves. Also by analogy Newton connected observed gravitational force on Earth to the mystery of what holds the moon and planets in their orbits, but he refused to mix in any religious thoughts about God's design. When others wondered why he had not explained *why* the rays of light and the force of gravity behave the way they do or why both follow an inverse square law, he replied, "But hitherto I have not been able to discover the cause of those properties of gravity from phaenomena, and I frame no hypotheses" (Newton [1686] 1962, 546–47). He meant that he had explained the laws but would not make metaphysical speculations, as Kepler and others had. In the *Optics* Newton stated, "the main business of natural Philosophy is to argue from Phaenomena without feigning Hypotheses, and to deduce Causes from Effects," and then added, "Till we come to the very first Cause [God], which certainly is not mechanical" (quoted in Hall 1992, 222).

With the last part of the statement Newton calmed others by indicating a belief in divine design, but he may not have been optimistic about science's ability to discover such ultimate mechanisms that acted without material substance and mechanical interaction. The question of what gravity actually is seemed unapproachable and was left in mystery by virtue of its acting in the void of empty space and being nonmechanical (Hall 1992, 222–23). Newton recognized that God could do whatever God wished. Gravity might well be a result of God wishing that things would hold together. In that way his theology affected his science (Ashworth 2003, 83).

Newton did have many religious reflections. He wrote on the Book of Revelation, but he kept his writings private (Bronowski 1973, 234). Rupert Hall suggests that Newton bifurcated his scientific work and his search for God because he could not proceed with both simultaneously (1992, 376). So God's workings were placed outside of science. Jacob Bronowski calls this separation a "massive achievement" in the nature of doing science (1966, 35). Newton defined *cause* in science and left divine patterns and purposes to theologians.

Not everyone immediately followed Newton's removal of God from the laboratory and the field study. Change in the thought patterns of an entire community is gradual, and natural theology was still dominant. For example, Carl Linnaeus (1707–1778), another devout Lutheran, spent much of his career attempting to determine the original biblical "kinds" created by God. He proceeded to classify the plants and animals, inventing binomial nomenclature, a system that grouped creatures. Initially, Linnaeus wanted each species he identified to represent a biblical "kind." Like Kepler, he tried to discern the patterns in the mind of God during creation. He also stated that he wished to undo the confusion of tongues that occurred at Babel and create a universal language for classification. Whereas he produced a universal system of classification that has lasted to this day, he realized that he had failed to find the "kinds" (Koerner 1999, 24–25).

Gradually, the scientific community moved away from all of the presuppositions that directly involved God. Presuppositions that were kept, such as analogy and the use of mathematics, were modified (Campbell 1952, 94ff., 153) and no longer referred to the original justifications. Thus, Charles Darwin (1809–1882) proposed a *natural* mechanism to explain how populations of organisms can evolve by applying economy theory, developed by Thomas Malthus, to nature (Lewontin 1993, 10). Presuppositions are always needed, but one can see that our vices often stem from our virtues (Galstad 1984, 30). The reasonable move to a practical naturalism in the laboratory can, for some, shift to a philosophical naturalism that entirely eliminates God.

A more modern presupposition list now includes:

1. Nature is mechanism: interaction of matter (from Newton).
2. All natural events have natural causes (naturalism).
3. Natural mechanisms can be understood by understanding the parts of the mechanism (reductionism).

Other presuppositions are modified. A few examples:

1. Analogies (physical or mathematical) between systems are valid ways to understand. If analogies fail, such as in understanding the nature of light as either particle or wave depending on the experiment, we continue to look for a deeper truth.

2. Beauty is a mark of truth.
3. Make no more explanation than necessary. (Ironically, Occam's razor is now turned against adding supernatural explanations [Carroll 2005]).

One can still see remaining shadows of the early presuppositions. James Watson revealed that he felt that his DNA model, constructed with Francis Crick, was correct *because it was beautiful*. On the verge of discovering the manner of how the four different bases would fit inside the two helical strands, Watson wrote to Max Delbruck that he "had just devised a beautiful DNA structure which was completely different from [Linus] Pauling's" (Watson 1968, 190). Again, he states, "although our idea was aesthetically elegant, the shape of the sugar-phosphate backbone might not permit its existence. Happily, now we knew that this was not true, and so we had lunch, telling each other that a structure this pretty just had to exist" (p. 205). By their own statements Watson and Crick claimed to have no religious faith, yet this presupposition was still in their worldview. For many in science beauty is still a mark of truth.

Naturalism in Science

Newton's choice directed science toward naturalism. In our century it seems to be practiced along a continuum (see Figure 1). At one extreme is the individual open to seeing the Divine acting in every event. Another person may only allow naturalism in scientific work but be able to entertain a wider view of reality that allows for the transcendent when not doing science. At the other extreme is the individual who maintains that the interactions of matter and energy have only natural causes. Paleontologist Richard Dawkins is well known for this position. He maintains that if the God hypothesis is truly meaningful it should be subject to a test (Johnson 2005). Furthermore, the sister of natural cause is reductionism: If one takes a mechanism apart and understands the functions of its pieces, one may claim to know the object.

Geneticist Richard Lewontin (1993, 11–12) suggests that when society elevated the importance of the individual, science also changed its view of the value of the parts and pieces of organisms. Whereas the medieval mind saw the wholeness and the transcendence of nature, the modern scientific

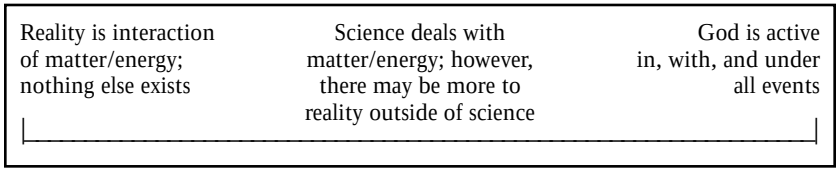

Fig. 1. A continuum of worldviews based on presuppositions

mind is more likely to dissect and find satisfaction in parts. It can reduce explanation to that level. Lewontin and others have strongly expressed that our increased focus on reductionism has caused many to think that we are merely products of parts of our bodies—merely our genes (1993, 14). They are concerned that such thinking can lead us to incomplete answers that miss essentials such as the important effects of the environment that can interact with the genes. Lewontin notes that scientists may even be asking the wrong questions in the first place (2000, 109).

Lewontin is concerned about scientific explanations and social effects, but we need to consider that such thinking also has theological implications. Consider the existence of the soul. The *Catechism of the Catholic Church* (1994, 93) defines the human soul as "the innermost aspect of man, that which is of the greatest value in him, that by which he is most especially in God's image." The body is animated by the soul; separation of body and soul results in death of the body.

One would think that the soul is a theological concept with much mystery surrounding it. The soul is not material, and we know little about how it associates with the body. Hence, the soul is supernatural and ought to be outside the sphere of science. However, in the spirit of materialism and reductionism Crick proposed the "Astonishing Hypothesis" (1994, 3): "that 'You,' your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules." No soul, no being; just neurons firing. Crick adds, "Only scientific certainty (with all its limitations) can in the long run rid us of the superstitions of our ancestors. A critic could argue that, whatever scientists may say, they really do believe in the Astonishing Hypothesis. There is a restricted sense in which this is true. You cannot successfully pursue a difficult program of scientific research without some *preconceived ideas* to guide you" (p. 257; emphasis added). Clearly, one of the preconceived ideas is that nothing supernatural exists.

Presuppositions play into every aspect of science. Michael Behe (1996) has called attention to several complex mechanisms that Darwinism cannot presently explain by its use of natural selection and gradualism. Behe asks how an organism can build a complete mechanism part by part if the mechanism cannot operate until it is finished. An incomplete mechanism with unused parts would be detrimental to the fitness of the organism. One example of such a mechanism involves the evolution of all of the chemicals required for blood clotting. Behe and several others believe that this calls for recognition of an Intelligent Designer who has used special means to put the mechanisms into existence.

One would think that each of Behe's examples would be analyzed and a detailed evolutionary defense, probably involving co-option (other productive uses for the parts until the mechanism is complete), put forth.

Instead we find that most quickly reject Behe on a more fundamental level. At least three factors cause that rejection. One is the presupposition that all natural events *must* have natural causes. The Intelligent Designer is clearly supernatural; hence, critics often say "Intelligent Design is just not science" or suggest that it is a Trojan horse with Creationism inside (Biever 2005). Another factor is the perception that adding God to the explanation is not as simple as saying that nature evolved. The medieval mind would be more open to seeing God in, with, and under everything, but reductionism sees separate parts. It follows, in some modern minds, that another part is being added, and Occam's razor is applied. The third reason may be that, according to science historian Thomas Kuhn (1962, 77), presenting a few anomalies in science is not enough. The history of science shows that to overthrow a theory one must also have an attractive alternative theory that both explains and predicts. Prediction suggests new experiments and further observations. Many complain that Intelligent Design does not *go* anywhere.

Presuppositions can close minds subconsciously or throw up caution flags. Interestingly, the proponents of Intelligent Design are also being sensitive to the naturalism presupposition when they refuse to say who the Designer might be. Humphrey Palmer writes that accepting presuppositions does lead people to look in certain directions but does not determine what will be seen: "Whatever the spectacles we wear, we are free to look—and see" (1985, 170). And what if we do not like what we see or if we suspect that there is more to life? Can we then change our presuppositional spectacles? To do that, we first need to realize that we have presuppositions, states Palmer. He adds, "The thinker who leads an unexamined life *is* bound by his present set of principles, inherited or acquired."

Science is a process of investigation and a body of content accepted by a community of its practitioners. Experiment and observation are used to test and retest nature. However, data do not speak for themselves; they must be interpreted. We do not answer our questions simply by experience or by experiment. We sort the data, choose some, value some, and ignore others. Hence, science becomes a framework of thought and empiricism. Scientific presuppositions do play into the entire thought framework. Science cannot claim to be purely objective; it is a human activity. Some believe that transcendent qualities do not exist because science has not uncovered them. But at the heart of this is that some assume that matter and energy are all that exist, and if God *would* appear to them they would question their sanity.

Others suggest that one's personality is only a pile of active neurons. Better than challenging the conclusion, we need to look at the presuppositions. C. S. Lewis reminded us that merely seeing and explaining can go wrong. He wrote, "you cannot go on 'explaining away' forever: you will find that you have explained explanation itself away. . . . To 'see through' all things is the same as not to see" (1944, 86–87).

No conflict between science and theology should occur if both are done well and recognize their limits. Nature and revelation should come together if God is author of both. However, if the presuppositions of the two fields are in conflict or exceed their limits, results will not agree. When people do not realize that presuppositions are in their system of thought, they find it quite upsetting to confront another system that has different, equally hidden, assumptions (Palmer 1985, 175). More often it seems that people are not very philosophical, which means that they do philosophy poorly. This explains what is often seen in the writings of some who defend evolution and others who attack it. The exchanges are often reduced to insulting and questioning the other side's intelligence.

For example, philosopher Robert Pennock defends evolution in several ways including pointing out that different worldviews are involved. But then he adds that, when comparing religions, "from without, the Genesis account sounds equally silly. Did God really shape Adam from the dust and then make Eve starting with one of Adam's rib bones? Did a snake really talk Eve into eating a fruit that gave her knowledge of good and evil, and was it then cursed by God to crawl, limbless, on its belly?" (Pennock 2000, 351)

On the other hand, while debating the introduction of a bill to "teach the controversy" in Oklahoma State Representative Tad Jones stated, "Do you think you come from a monkeyman? Did we come from slimy algae 4.5 billion years ago or are we a unique creation of God?" (Talley 2006)

Both of the above are examples of superficial arguments taking place at the wrong level. The statements do not attempt to get at the conflict in presuppositions that underlie the problem. Both the evolutionary and creationism targets of the above attacks have presuppositional understandings underlying them that need to be uncovered and evaluated.

Presuppositions need to be on the table. Scientists who boldly assert that reality consists exclusively of the interactions of matter and energy need to examine the roots of that claim and recognize it as a basic assumption that is useful only within narrow limits. Presuppositions are not proven, and such extreme use of naturalism without question cannot be justified and becomes scientism. Naturalism rules out the transcendent and the supernatural. This may be a practical and temporary suspension of thought to make in the laboratory, but it ought to be recognized as such. Tension will remain if some push the application of naturalism to all forms of knowledge and experience. On the other hand, if some theological presuppositions lead to proposing that God may have left God's signature in the complex design of a particular chemical mechanism, this can also lead to tension and a lack of communication when the foundations of this conflict are not recognized. As in the case of Kepler, such claims of God's design in nature may be falsified, and faith may be wrongly challenged. One can assume too little or too much, but when presuppositions are rec-

ognized and articulated, constructive discussion resulting in better understanding can begin.

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